

**EVALUATION OF THE USE OF LARGE AREA VERIFICATION  
FOR THE MONTICELLO REMEDIAL ACTION PROJECT**

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Date Submitted: January 2001

Prepared for the  
U.S. Department of Energy  
Grand Junction Projects Office  
under contract DE-ACO500OR-22800

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## Acronyms

AIMTech	Advanced Infrastructure Management Technologies
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FUSRAP	Formerly Utilized Sites Remedial Action Program
GJO	Grand Junction Office
GJORAP	Grand Junction Office Remedial Action Project
HOG	highest outdoor gamma
IV	independent verification
IVC	Independent Verification Contractor
LAV	large area verification
MPPs	Monticello Peripheral Properties
MRAP	Monticello Remedial Action Project
MVC	Monticello Vicinity Properties
OUII-MPPs	Operable Unit II Non-Groundwater-Related Peripheral Properties
UMTRAP	Uranium Mill Tailings Remedial Action Project
UDEQ	Utah Department of Environmental Quality
RAC	Remedial Action Contractor

## Executive Summary

Large area verification (LAV) sampling protocol is used to demonstrate that remedial action for uranium mill tailings has been effective on land areas greater than 100 m<sup>2</sup> (generally 800–1100 m<sup>2</sup>). LAV protocol was used under certain conditions during the Monticello Remedial Action Project (MRAP) versus the standard method for sampling. The U.S. Environmental Protection Agency (EPA) regulation promulgated in 40 CFR 192 specifies that average concentrations be calculated over an areal extent of no more than 100 m<sup>2</sup>. The number of samples required for demonstrating compliance to this regulation for large parcels can be burdensome and expensive. LAV was implemented at various projects under oversight of the U.S. Department of Energy/Grand Junction Office (DOE/GJO) to reduce sampling costs. For MRAP, LAV was only to be used on areas with homogenous contamination—where there was no evidence of buried contamination or disturbed soils. Also, LAV was only to be used on excavated areas where soil replacement was required, so the radium-226 (<sup>226</sup>Ra) criterion for excavation was 15 pCi/g. The largest area represented by a single LAV composite area was not to exceed 10,800 ft<sup>2</sup>. LAV was not to be performed within 10 ft of a structure. Finally, DOE was asked to clearly state in its engineering packages whether LAV was intended for use on the respective MRAP sites.

Advanced Infrastructure Management Technologies (AIMTech)\* is the Independent Verification Contractor (IVC) for MRAP. The IVC collected independent data on 10% of the Monticello Peripheral Properties (MPPs). One objective of this activity was to ensure that the LAV protocol provided reasonable assurance that remedial action was effective. The IVC accomplished this objective by performing independent verification (IV) surveys on ~10% of the excavated areas on selected MPPs. The IV surveys consisted of collecting soil samples for <sup>226</sup>Ra at the locations of the highest gamma radiation readings in each grid block (30 ft by 30 ft) versus combining aliquots from each area into one composite sample as set forth in the Remedial Action Contractor's (RAC's) LAV protocol. The individual results and the mean average of the combined results from the IVC analyses were compared to the RAC's LAV results to ensure that the method did not dilute anomalous <sup>226</sup>Ra concentrations, whereby residual radioactive materials would potentially remain in place and present a risk to human health and the environment. Furthermore, the biased sample results were compared to hot-spot criteria—another area-averaging technique developed by DOE that provides criteria by which it is determined whether small pockets of elevated concentrations of residual radioactive material require remediation.

Independent Verification data show that mean average concentrations of LAV-biased samples comply with project requirements in all but three cases. The areas where samples exceeded criteria were subject to further investigation/remediation and verified to be within acceptable radiological levels (MACTEC 1999a and b). It should be noted that LAV protocol does not provide sufficient sample density to show compliance with the 100-m<sup>2</sup> criteria in the 40 CFR 192 standard. However, assuming that gamma radiation is representative of the <sup>226</sup>Ra concentrations in the soil and that the hot-spot test is appropriately applied, then the procedure is assumed to be effective in documenting surface layer conditions of excavated areas.

Finally, a nonparametric statistical tool that calculates one-sided upper confidence limits on percentiles was applied to the IV data set (291 samples), which requires a minimum sample size

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\* AIMTech was formerly the Environmental Technology Section of Oak Ridge National Laboratory.

of 99. The test shows, with 95% confidence, that 99% of the soil in the remediated area is projected to be below 98 pCi/g and 85% of the soil is projected below 15 pCi/g. This demonstrates reasonable assurance that project criteria were met, assuming that the areas verified by IVC represent the entirety of the remedial action.

## **1. Introduction**

Advanced Infrastructure Management Technologies (AIMTech)\* is the Independent Verification Contractor (IVC) assigned by the U.S. Department of Energy Grand Junction Office (DOE/GJO) for the Monticello Remedial Action Project (MRAP). MRAP removed radioactive uranium mill tailings from a former mill site and surrounding properties in Monticello, Utah. The IVC collected independent radiological data on 10% of the Monticello Peripheral Properties (MPPs) in order to ensure that cleanup was adequate and that radiological levels complied with project criteria.

During the regulatory review of Operable Unit II Non-Groundwater-Related Peripheral Properties (OUII-MPPs) Remedial Action Contractor (RAC) completion reports and IVC reports, the U.S. Environmental Protection Agency (EPA) and Utah Department of Environmental Quality (UDEQ) had several concerns regarding the use of the Large Area Verification (LAV) Protocol and application of hot-spot criteria. Twenty-one OUII-MPPs underwent remedial action. The IVC performed site surveys and sampling on seven of these properties: MP00105, MP00211, MP00845, MP01040, MP01041, MP00948, MP00964, and MP00949. The IVC performed surveys on ~10% of all Monticello properties. The IVC has historically been skeptical of the use of LAV, except where contamination is homogeneous as found in UMTRAP properties where tailings were evenly dispersed by wind. Therefore, during IVC site surveys in Monticello, data was collected on ~10% of the remediated area to demonstrate the adequacy of the LAV protocol. The objectives of this report are to present supporting data for the use of LAV in Monticello as well as to state the limitations of the LAV protocol.

### **1.1 History of Large Area Verification Protocol**

LAV protocol was adopted from the Uranium Mill Tailings Remedial Action Project (UMTRAP) and amended for use on MPPs, which are tracts of land on the periphery of the mill site that encompass areas greater than ½ acre. For Monticello properties, LAV was to be used only on areas with homogenous contamination (primarily windblown), where there was no evidence of buried contamination or disturbed soils. Also, LAV was to be used only on excavated areas where soil replacement was required [i.e., radium-226 (<sup>226</sup>Ra) criterion for excavation was 15 pCi/g] and was not to be performed within 10 ft of a structure. The largest area represented by a single LAV composite area in Monticello was not to exceed 10,800 ft<sup>2</sup>. Finally, DOE was asked to clearly state in its engineering packages whether LAV was intended for use on the respective sites.

LAV protocol is applied by using a 30- by 30-ft grid overlain on the excavation. Aliquots are collected at the highest outdoor gamma (HOG) location within each grid block. Aliquots from 2 to 12 adjacent grid blocks are combined to form a composite sample.

The IVC had several concerns about using LAV on the Grand Junction Office Remedial Action Project (GJORAP) and UMTRAP. These concerns were expressed in May 1992 and ultimately resulted in DOE Headquarters calling for the suspension of LAV at GJORAP in 1993 and

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generating a risk-based certification for the areas already backfilled. These early concerns are expressed in the bullets below. It should be noted that EPA approved the use of LAV in Monticello with certain restrictions that were documented in technical memorandums (see Appendix A and EPA 1992).

- LAV did not show compliance with the 100-m<sup>2</sup> requirement of 40 CFR 192 and DOE Order 5400.5 which were GJORAP requirements.
- The protocol was based on cost savings and at that time had not been subjected to a data quality objectives review or other independent technical evaluation.
- LAV relies heavily on the correlation between gamma exposure rate and radium soil concentrations, which sometimes do not correlate well.
- There was a loss of equilibrium in GJORAP soils between <sup>226</sup>Ra and thorium-230 (<sup>230</sup>Th); therefore, LAV at the site could not be conclusively relied upon to demonstrate compliance of <sup>230</sup>Th to DOE Order 5400.5. It should be noted that Monticello soils did not show a significant disequilibrium between <sup>226</sup>Ra and <sup>230</sup>Th as indicated by the RAC verification database.
- The first applications of LAV at GJORAP failed to meet the criteria for <sup>230</sup>Th, resulting in re-excavation and further remediation.
- Gamma screening action limits for GJORAP were lowered to near background for <sup>226</sup>Ra in order to account for the residual thorium that became the driver under 5400.5. The lower limit allowed for removal of the thorium while still screening for radium.
- LAV was used in conjunction with the cobbles-and-fines protocol in areas of alluvium, and the IVC was concerned that there was a double-dilution of representation as compared to actual site conditions.

Again, LAV was approved for use for Monticello Vicinity Properties (MVPs) and MPPs in 1994 (EPA 1994) providing that DOE complied with specific criteria (Appendix A and EPA 1992). These memoranda provided controls that were applied to the use of LAV on the OUII-MPPs listed in Sect. 1. The RAC used LAV on MVPs and MPPs according to their procedure in the *Field Assessments Procedures Manual* (MACTEC 1998) and with respect to the controls mentioned above.

## **2. Compliance with the Hot Spot Criteria and 40 CFR 192**

### **2.1 Hot-Spot Criteria**

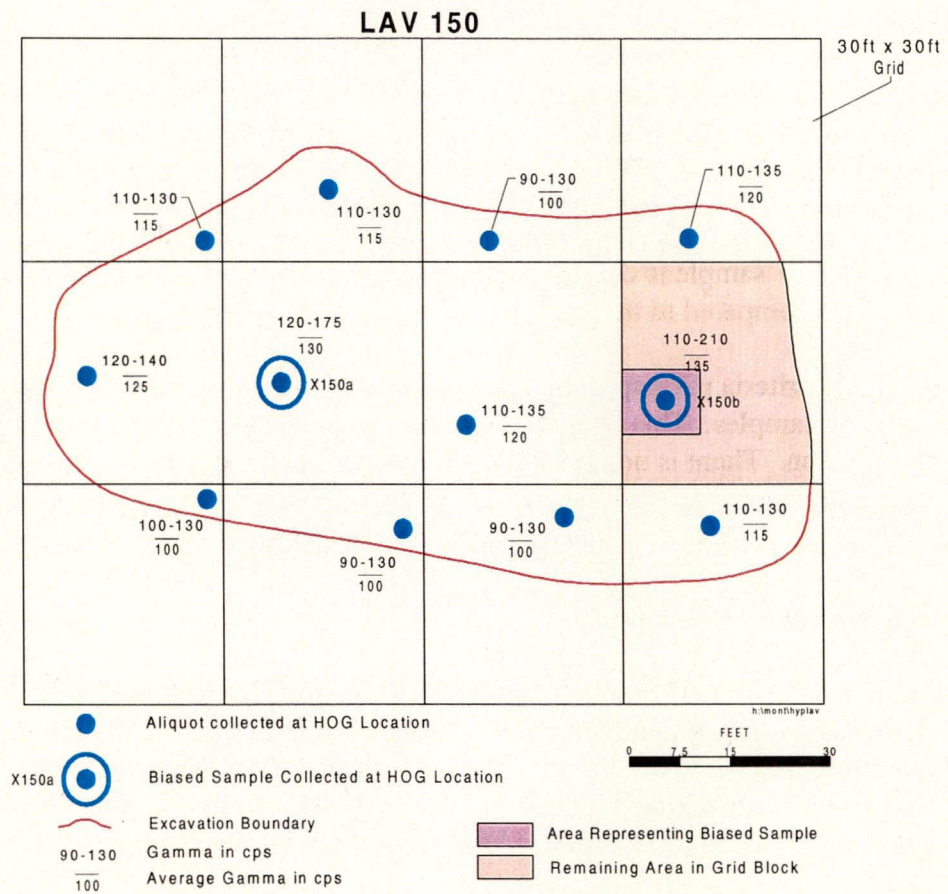
Hot-spot criteria were included in the Formerly Utilized Sites Remedial Action Program (FUSRAP) and DOE Order 5400.5 by reference. The hot-spot area-averaging technique was developed by DOE, and provides criteria for which it is determined whether small pockets of elevated concentrations of residual radioactive material require remediation. These criteria were adopted for use in the Monticello Projects as part of the Federal Facilities Agreement (FFA). When the LAV sample is collected at the location of the highest outdoor gamma measurement (HOG), it is compared to these criteria as well as the 15-pCi/g standard.

The hotspot criteria put upper limits (30 times the criterion) on  $^{226}\text{Ra}$  concentrations of verification samples. This requires that small, isolated deposits with areas up to 25 m<sup>2</sup> be subject to remediation. There is no upper constraint to the residual concentration under 40 CFR 192—just a requirement that an average concentration per 100-m<sup>2</sup> area does not exceed the specified limit (5/15 pCi/g for surface/subsurface soils, respectively).

### **2.2 Area-Weighted Averaging**

During the remediation of Monticello Vicinity Properties (as well as UMTRAP and GJPORAP), precedent was set that, if contamination was to be left in place for certain purposes (worker safety, mature trees, and building structure integrity), compliance with the 40 CFR 192 and hot-spot criteria was demonstrated by taking a biased sample from a contaminated area and “area-averaging” the concentration with a sample from the remainder of the 100-m<sup>2</sup> area.

The RAC attempted to use area-averaging protocol during remediation of the large MPPs but primarily for expediency versus the purposes mentioned earlier in this document. However, in the case of LAV, using the area-averaging method is problematic (Fig. 1). Concentrations for biased samples can be factored into the area-weighted average, but there is no sample concentration representative of the remaining area in the 100-m<sup>2</sup> grid block (shaded area in Fig. 1). Regardless, concentration of the biased sample can be compared to the hot-spot criteria with the data available. Indeed, hot-spot criteria are more conservative than area-averaging alone. In other words, the result of area-weighted averaging is never going to exceed the applicable criteria when it doesn't exceed the hot-spot criteria. Therefore, the presentation of area-averaging data in both RAC's completion reports and the IVC reports is superfluous and confusing to the reader.



**Fig. 1. Hypothetical large area verification (LAV) unit.**

### **3. Independent Verification of Large Area Verification Protocol**

The IVC has historically been skeptical of the use of LAV, except where contamination is homogeneous as found in UMTRAP properties where tailings were evenly dispersed by wind. Because of the inhomogeneous nature of the contamination from the mill site (i.e., point sources), the IVC felt that it was prudent to provide several checks and balances on the LAV protocol throughout the remediation of MPPs. The two measures taken to demonstrate the effectiveness of IV are described below.

#### **3.1 MP00964 Independent Verification Contractor Site Survey**

Prior to June 1998, the IVC used standard protocol on approximately 10% of LAV areas to ensure that the use of LAV was providing adequate proof of successful remedial action. This method was used on MP00964 and documented in the IV report, which was included in the OUII-MPP submittal to the regulators. The IV survey of MP00964 included the collection of 16 LAV samples, where IVC  $^{226}\text{Ra}$  ranged from 1.5 to 3.2 pCi/g. One 30- by 30-ft (~10- by 10-m<sup>2</sup>) block was selected from each of the 16 LAVs and standard protocol applied. The RAC's  $^{226}\text{Ra}$  results ranged from <1.0 to 3.1 pCi/g, and are within the range of the IVC results. The IVC concluded that LAV adequately described the radiological condition of the property and that remedial action was successful (ORNL 1993).

#### **3.2 Independent Verification Contractor Surveys of Mill-Site-Related Properties**

After June 1998, when MPPs related to the mill site were undergoing remediation, a different method was used to check LAV protocol. A single sample was collected from the location of HOG in each LAV block, providing the IVC with up to 12 separate  $^{226}\text{Ra}$  results for the LAV, as depicted in Fig. 1. Instead of physically compositing the aliquots, samples were analyzed separately, compared to hot-spot criteria, and then mathematically averaged for comparison to RAC results. In other words, each aliquot was treated as a biased sample regardless of its gamma exposure rate and associated area. LAVs were scanned prior to sampling using GPS coupled with gamma scintillation. Data contained in the project database include LAVs from MP00105, MP00391, MP00179, MP00181, MP00211, and MP00845. Although some of these properties are not included in the OUII-MPPs, the data are used herein to evaluate LAV protocol.

Appendix B is a compendium of LAV data acquired during IVC surveys of MPPs related to the mill site remediation and used for analysis in this study. Appendix C presents statistical evaluation of the sample data. Concentrations of  $^{226}\text{Ra}$  greater than or equal to 15 pCi/g are highlighted and their gamma exposure rate contour maps provided in Appendix B. These data were sorted and are presented in Appendix C, Table C.1. The  $^{226}\text{Ra}$  concentrations of biased HOG samples ranged from 0.78 to 98.6 pCi/g (Appendix C, Table C.2). The mean average  $^{226}\text{Ra}$  was 7.6 pCi/g; the median, 4.1 pCi/g; and the mode, 1.6 pCi/g. These averages are far below the 15-pCi/g subsurface standard, as expected. The highest values in the data set were from samples collected on MP00181 and were addressed by further excavation and verification of the areas.

Thirty-six (36) of 291  $^{226}\text{Ra}$  concentrations met or exceeded 15 pCi/g (approximately 12%). However, only one of these results exceeded hot-spot criteria (Appendix B, MP00181, LAV 2294, Block 2389). Again, this location was subject to further investigation and remediation

after the IVC notified DOE of the anomalous result. Graphical displays of contoured gamma, along with corresponding sample locations and analytical data for the LAV areas used in this study, are provided in Appendix B. It should be noted that the program that contours gamma extrapolates the area associated with each measurement point. Therefore, the areas provided in Table 1 can be considered conservative.

The mathematical mean concentrations of LAVs (Table 1, column 3) range from 1.6 to 13.9, excluding blocks where further remediation was conducted (LAVs 1832 and 2297). Table 1 also compares IVC mathematical averages to RAC composite results. IVC results are generally higher than RAC results and correlate poorly. Indeed, the mean of the ratios is 2.0, indicating that IVC results average about twice the concentration of RAC results. This is attributed to the difference in both field and analytical methods used by the two contractors. Regardless, all blocks except those subject to further remediation on MP00181 meet the project criteria.

A nonparametric statistical tool was applied to IV data shown sorted in Appendix C, Table C.1. A one-sided upper confidence limit on percentiles was used, which requires a minimum sample size of 99. The results of this test are shown in Appendix C, Table C.3 and Fig C.1. The test shows that 86% of the remediated area is projected to have  $Ra^{226}$  concentrations below 15 pCi/g at the 95<sup>th</sup> confidence level. Also with 95% confidence, the test shows that 99% of the soil in the remediated area is projected to be below 98 pCi/g and 85% projected below 15 pCi/g. This demonstrates reasonable assurance that project criteria were met, assuming that areas verified by the IVC represent the entirety of the remedial action.

Table 1. IVC mathematical average versus RAC composite result (pCi/g)				
Peripheral Property Number/Phase	LAV No.	IVC Average (pCi/g)	RAC Composite (pCi/g)	Difference (pCi/g)
MP00105/PHII MP00391/PHII				
	107	9.432	1.4	8.03
	306	6.379	4.8	1.58
	449	11.466	4.2	7.27
MP00179/PHIII	6658	6.898	5.7	1.20
	6745	3.233	2.4	.83
MP00179/PHIII Creek Corridor	6174	13.312	3.8	9.51
	6316	6.891	6.57	0.32
	6352	13.914	4.4	9.51
	6465	3.746	4.2	-0.45
MP00181/PHIA	930	8.84	3.7	5.14
	1264	12.476	6.7	5.78
MP00181/PHIA Creek Corridor	1311	9.124	2.2	6.92
MP00181/PHII	550	3.609	6.6	-2.99
	910	9.39	4.6	4.79
	1586	1.685	2.4	-0.72
	1719	10.91	6.4	4.51
	1832	26.89**	11.4	15.49
	2191	10.999	9.3	1.70
	2297	45.163**	2.5	42.66
	2574	6.288	4.8	1.49
	2677	5.359	2.2	3.16
MP00181/PHIVA	315	6.234	5.9	0.33
MP00211/PHII	604	2.875	3.6	-0.73
	1137	4.295	4.8	-0.51
MP00391/PHIV	3774	4.534	10.8	-6.27
	5327	2.921	4.7	-1.78
MP00845	24	6	5.1	0.90
	32	3.1	6.1	-3.00
	35	10.779	4.9	5.88
	36	3.791	1	2.79
	56	1.881	2.123	-0.24
* Mean average is the mathematical concentration of the aliquots and is comparable to a composite concentration.				
**Subject to further remediation.				

## 4. Conclusion

While use of the LAV protocol is expedient when applied to large properties, there are limitations to its use with respect to the application of area-weighted averages. Furthermore, caution should be taken when applying LAV protocol to heterogeneous areas as well as those where multiple radionuclides/contaminants are present. Finally, using LAV on lands affected by emanation from a nearby source (shine) is troublesome since the method heavily relies on gamma fluence.

The use of LAV in Monticello had two safeguards: (1) the use of gamma screening and (2) the 10% IV of LAV areas. Gamma screening is particularly important in regard to the application of hot-spot criteria because uranium ore point sources are abundant at the site.

Independent Verification data show that concentrations of biased samples and their mean averages in all but three cases comply with both hot-spot criteria and 40 CFR 192. The three cases where project criteria were exceeded were subject to further investigation/remediation (MP00181-PII, LAV2191-Block 2191 and LAV 1832- Block 2019, and LAV 2297-Block 2389). Again, LAV protocol does not provide sufficient sample density to show compliance with 100-m<sup>2</sup> criteria in the 40 CFR 192 standard. However, if the assumption is made that gamma radiation is representative and correlated to soil concentrations and the hot-spot test is appropriately applied and documented, then the procedure can be assumed to be relatively effective in documenting surface layer conditions.

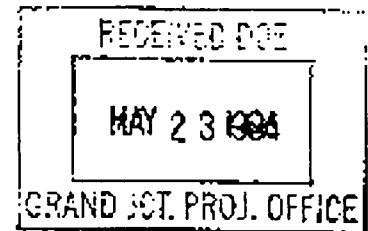
## References

- EPA. 1992. Letter to Larry Anderson, Director of the Division of Radiation Control, Department of Environmental Quality, Salt Lake City, Utah from Milt Lammering, Environmental Protection Agency. July 15, 1992. EPA, Region VIII, Denver, Colo.
- EPA. 1994. Letter to Donald Leske, Department of Energy, Grand Junction Projects Office from J. Mario Robles, Environmental Protection Agency. May 19, 1994. EPA, Region VIII, Denver, Colo.
- ORNL. 1993. *Results of the Type B Independent Verification of Radiological Remedial Action at Parcel #A33240312408, Monticello, Utah (MP00964)*. June 1993. Oak Ridge National Laboratory, Grand Junction, Colo.
- MACTEC. 1998. *Field Services Procedures Manual*. Section 3.0 Excavation Control and Verification Procedures. Revision 13, April 15, 1998. MACTEC ERS, Grand Junction, Colo.
- MACTEC. 1999a. Excavation and Control Survey Log. Field data signed by Ernie Colunga on November 2, 1999, regarding Block 2191. MACTEC ERS, Grand Junction, Colo.
- MACTEC. 1999b. Excavation and Control Survey Log. Field data signed by Ernie Colunga on November 3, 1999, regarding point source removal by IVC sampling on MP00181-P2. MACTEC ERS, Grand Junction, Colo.

## **Appendix A. EPA 1994**



REGION VIII  
999 18th STREET - SUITE 500  
DENVER, COLORADO 80202-2466



Ref: 6EWM-FP

May 19, 1994

Mr. Donald Leske  
Monticello Project Manager  
Grand Junction Projects Office  
U.S. Department of Energy  
Grand Junction, CO 81502-2567

Dear Mr. Leske:

The Environmental Protection Agency (EPA) and the State of Utah (the State) reviewed the "Statistical Data Package for the Large Area Verification Procedure". The data clearly indicates the Large Area Verification (LAV) procedure is not equivalent to the standard procedure; however, it can be utilized to identify that radionuclides remaining in the soil do not exceed the Ra-226 standards set by EPA. Also, EPA believes that the LAV procedure, when properly used on selected properties, can produce the same verification conclusions as the standard procedure. Consequently, EPA, in concurrence with the State of Utah, accepts the use of the LAV procedure for the Monticello Vicinity Properties NPL Site (MVP) and the Monticello Mill Tailings NPL Site Peripheral Properties (PP), providing the Department of Energy (DOE) agrees to comply with the following criteria:

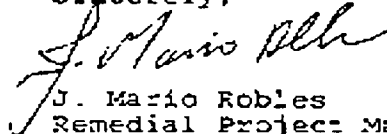
1. LAV shall only be used on areas where the depth distribution of the tailings is reasonably well known and where there is no evidence or indications of buried contamination or disturbed soils. LAV shall only be used on excavated areas where soil replacement is required, so that the Ra-226 criteria for excavation is 15 pCi/g.
2. Field analysis by the Copposed Crystal System (OCS) will constitute the final determination of whether an area is acceptable and 10 percent of all field samples will be submitted to laboratory analysis to assure that the OCS correlation is valid.
  - a. DOE must indicate in its LAV Standard Operating Procedures what steps will be taken if the laboratory analysis results exceed the Ra-226 criterion for samples acceptable by the OCS analysis.
  - b. The largest area represented by a single composite sample shall not exceed 10,800 square feet.

3. DOE states in the Radiologic and Engineering Assessment for the MVP or in the Remedial Action Design package for the peripheral properties (REA/RAD), whether it intends to use the LAV procedure to a particular property so EPA and the State can assess whether use of the LAV procedure is appropriate.
4. The use of LAV procedure for properties less than one-half acre must be requested in the REA/RAD package submitted to the State. Acceptance may be granted with the State approval of the REA/RAD.
5. DOE clearly states in the Completion Report which verification procedure was utilized.

EPA and the State are supportive of a cost effective remediation. However, we remain concerned about the environmental degradation and over-excavation that can result if the clean-up/verification process is not properly utilized. DOE needs to make certain that the LAV procedure is cost effective on any given property and that the use of this procedure does not result in costly over-excavation.

Should you have any questions, or need further clarification please call me at (303) 294-1983 or Ty Howard at (901) 536-4100.

Sincerely,



J. Mario Robles  
Remedial Project Manager  
Monticello Vicinity Properties Project

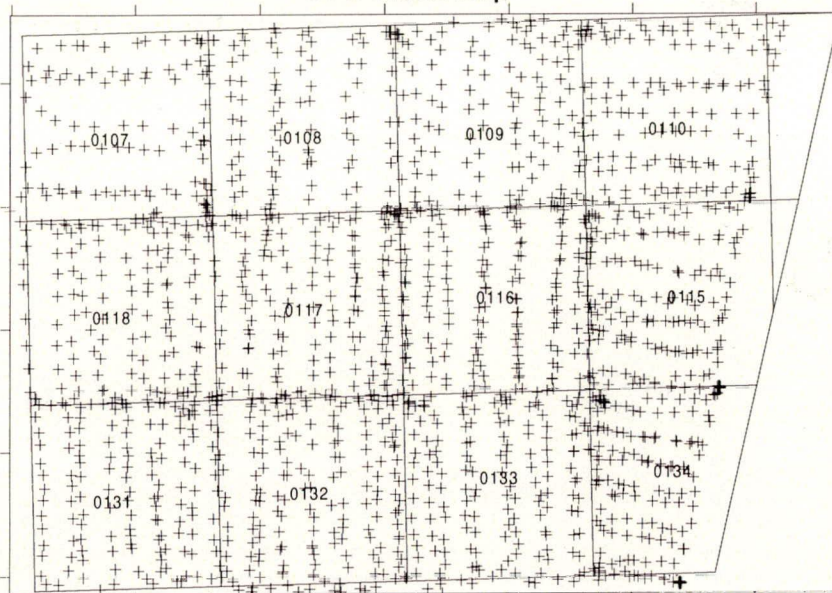
cc: Ty Howard,  
Utah Department of Environmental Quality

**APPENDIX B**  
**GAMMA EXPOSURE RATE CONTOUR MAPS AND ANALYTICAL RESULTS**

<b>Property ID No.</b>	<b>LAV No.</b>	<b>Page No.</b>
MP00105/MP00391	107.....	B-2
	306.....	B-3
	449.....	B-4
MP00179, Phase III	6658.....	B-5
MP00181, Phase II	910.....	B-6
	1586.....	B-7
	1719.....	B-8
	1832.....	B-9
	2191.....	B-10
MP00179,Phase III	6745.....	B-11
	6174.....	B-12
	6316.....	B-13
	6352.....	B-14
MP00181, Phase I	930.....	B-15
	1264.....	B-16
	1311.....	B-17
MP00181, Phase II	550.....	B-18
	2297.....	B-19
	2574.....	B-20
	2677.....	B-21
MP00181, Phase IV	315.....	B-22
MP00211, Phase II	604.....	B-23
	1137.....	B-24
MP00391, Phase IV	3774.....	B-25
	4184.....	B-26
	5327.....	B-27
MP00845	24.....	B-28
	32.....	B-29
	35.....	B-30
	36.....	B-31
	56.....	B-32

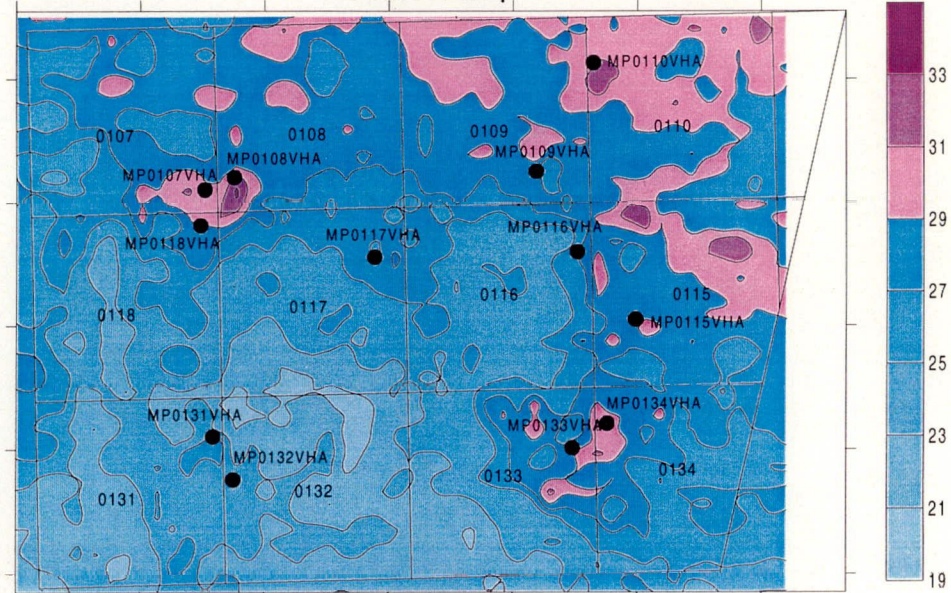
# MP00105/MP00391 LAV0107

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
107	MP0107VHA	6.05	0	0	10.703
108	MP0108VHA	13.80	0	0	
109	MP0109VHA	3.99	0	0	
110	MP0110VHA	3.86	0	0	
115	MP0115VHA	18.70	0	0	
116	MP0116VHA	13.30	0	0	
117	MP0117VHA	15.00	0	0	
118	MP0118VHA	11.20	0	0	
131	MP0131VHA	8.35	0	0	
132	MP0132VHA	7.30	0	0	
133	MP0133VHA	18.60	0	0	
134	MP0134VHA	8.29	0	0	

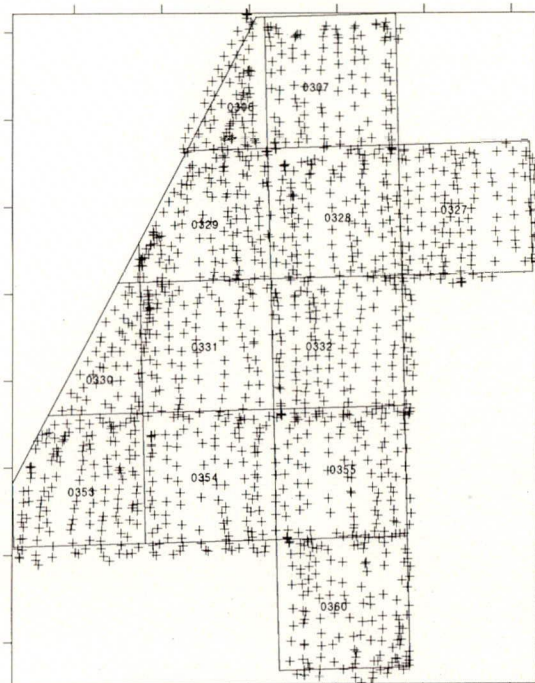
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



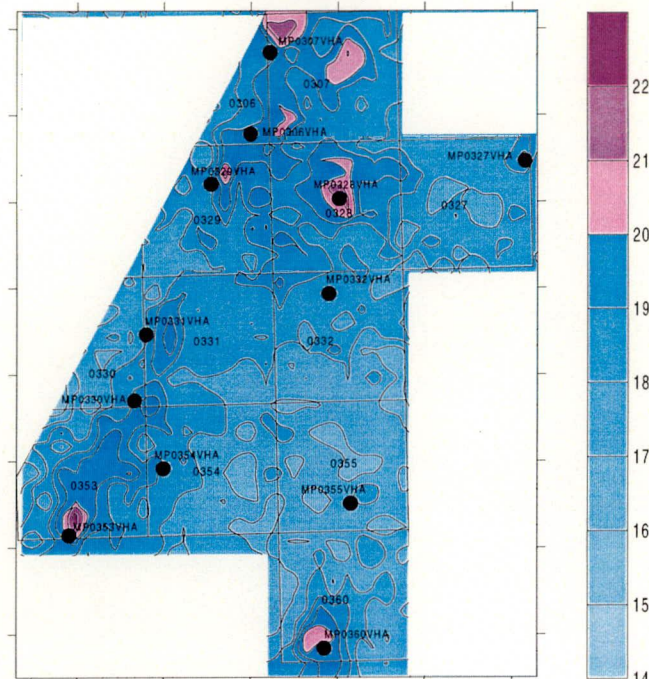
MP00105  
LAV0306

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
306	MP0306VHA	3.51	0	0	6.379
307	MP0307VHA	15.70	0	0	
327	MP0327VHA	3.13	0	0	
328	MP0328VHA	3.73	0	0	
329	MP0329VHA	13.30	0	0	
330	MP0330VHA	5.43	0	0	
331	MP0331VHA	6.49	0	0	
332	MP0332VHA	1.35	0	0	
353	MP0353VHA	13.90	0	0	
354	MP0354VHA	1.23	0	0	
355	MP0355VHA	1.07	0	0	
360	MP0360VHA	7.71	2	107	

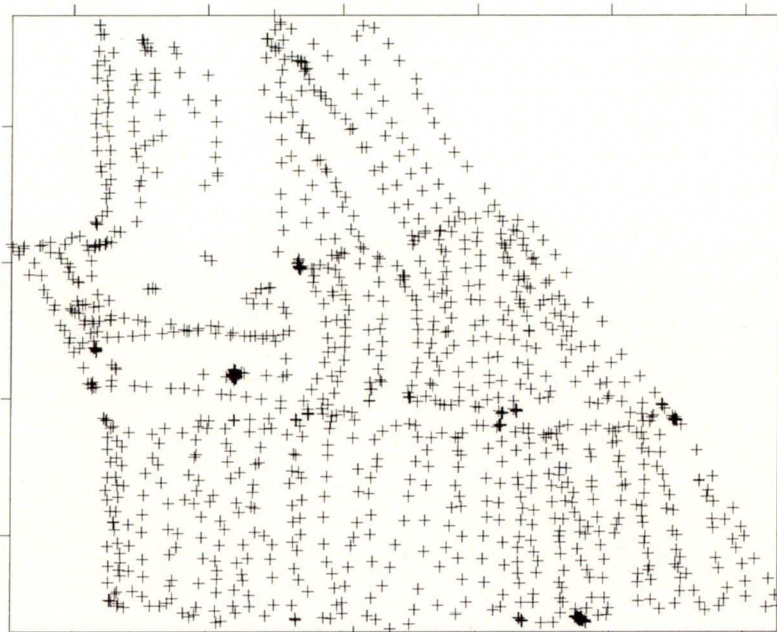
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



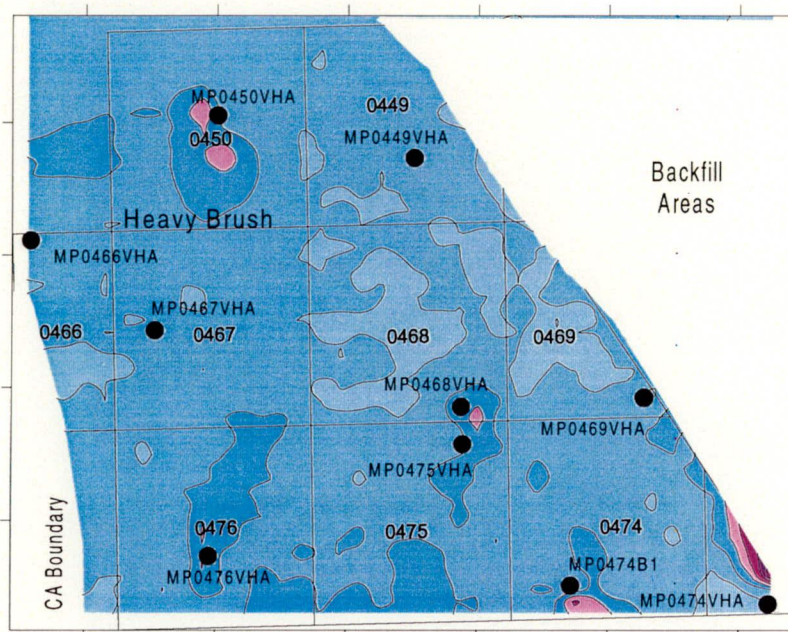
# MP00105/MP00391 LAV0449

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



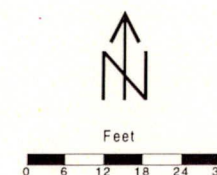
● Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
449	MP0449VHA	10.00	0	0	11.466
450	MP0450VHA	9.04	0	0	
466	MP0466VHA	1.03	0	0	
467	MP0467VHA	5.44	0	0	
468	MP0468VHA	7.60	0	0	
469	MP0469VHA	7.48	0	0	
474	MP0474VHA	40.60	5	68	
475	MP0475VHA	11.70	0	0	
476	MP0476VHA	10.30	0	0	

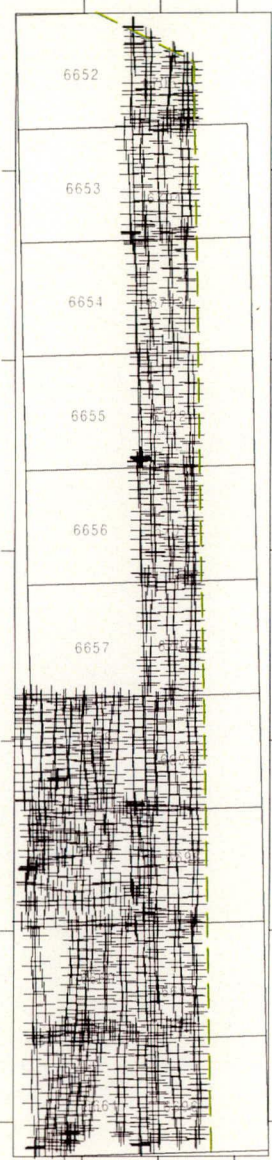
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



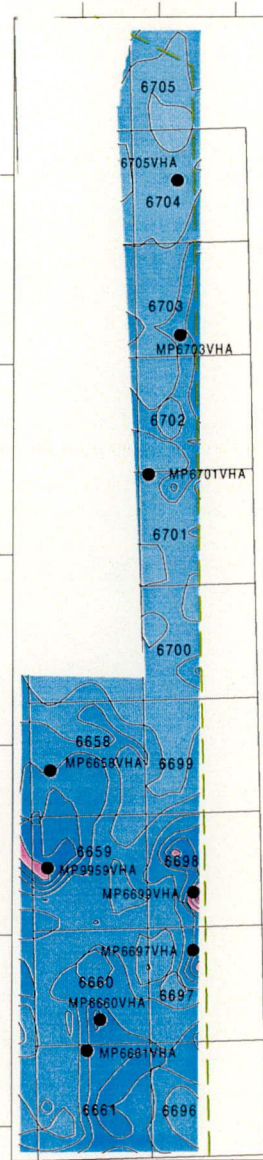
# MP00179 Phase III LAV6658

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

uR/h



Results of Sample Analysis

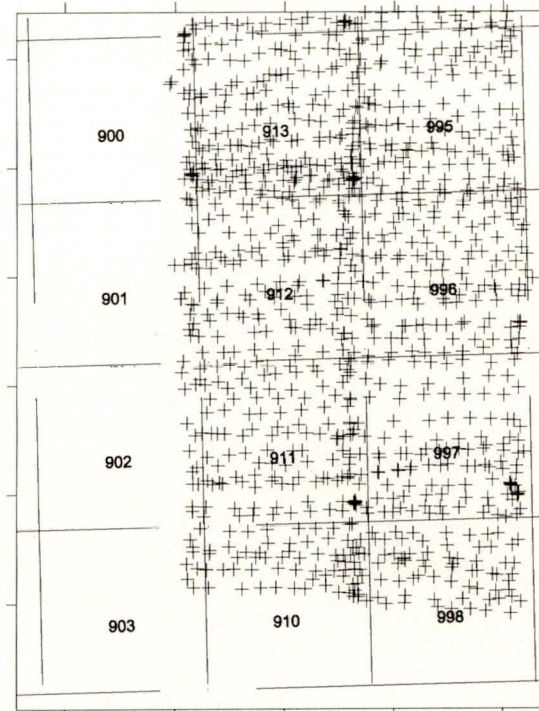
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
6658	MP6658VHA	9.19	0	0	7.397
6659	MP6659VHA	4.45	0	0	
6660	MP6660VHA	15.90	0	0	
6661	MP6661VHA	10.80	0	0	
6697	MP6697VHA	6.27	0	0	
6699	MP6699VHA	10.80	0	0	
6701	MP6701VHA	2.06	0	0	
6703	MP6703VHA	1.85	0	0	
6705	MP6705VHA	5.25	0	0	

  <sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils

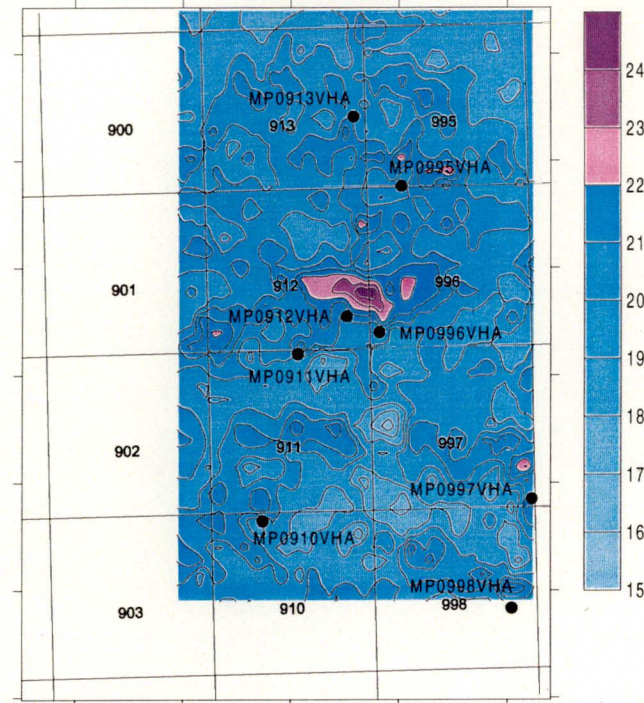
# MP181 Phase II LAV910

GPS Track Map



+ Gamma data point collected using GPS.

Contour Map



● Soil Sample Location

Results of Sample Analysis

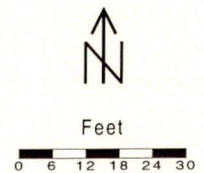
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
910	MP0910VHA	8.18	0	0	9.39
911	MP0911VHA	2.30	0	0	
912	MP0912VHA	2.69	4	76	
913	MP0913VHA	16.10	1	151	
995	MP0995VHA	8.10	1	151	
996	MP0996VHA	14.80	3	88	
997	MP0997VHA	4.25	2	107	
998	MP0998VHA	18.70	3	88	

<sup>226</sup>Ra concentration > 15 pCi/g

\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

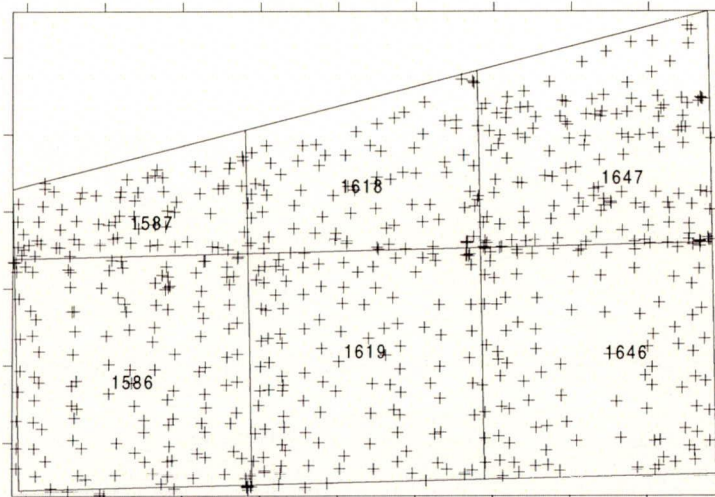
\*\* Original values are concentrations reported before resampling

\*\*\* Hot spot limit for subsurface soils



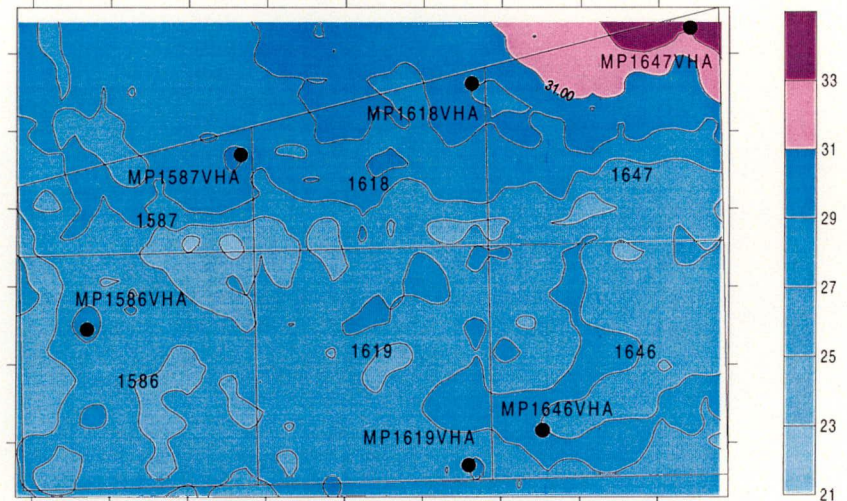
# MP181 Phase II LAV1586

GPS Track Map



+ Gamma data point location collected using GPS.

Countour Map



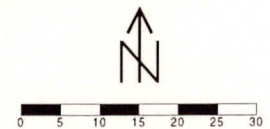
• Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
1586	MP1586VHA	1.07	0	0	1.685
1587	MP1587VHA	2.27	0	0	
1618	MP1618VHA	1.35	0	0	
1619	MP1619VHA	1.38	0	0	
1646	MP1646VHA	1.43	0	0	
1647	MP1647VHA	2.61	0	0	

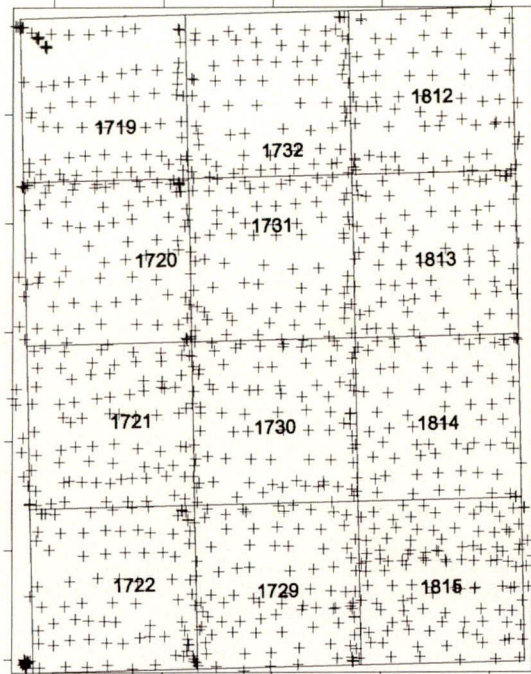
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



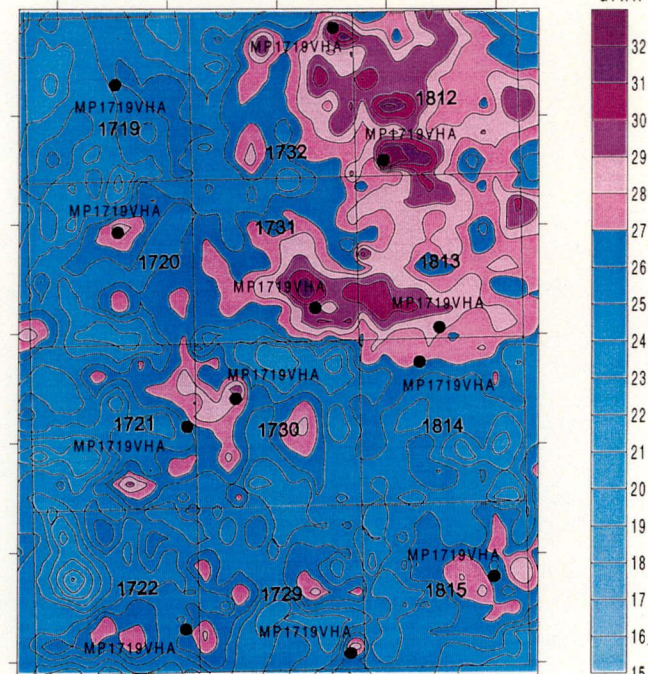
# MP181 Phase II LAV1719

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



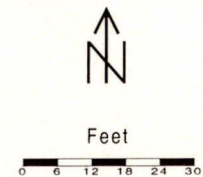
• Soil Sample Location

Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
1719	MP1719VHA	1.89	0	0	10.911
1720	MP1720VHA	2.63	0	0	
1721	MP1721VHA	9.00	4	76	
1722	MP1722VHA	8.29	0	0	
1729	MP1729VHA	17.00	1	151	
1730	MP1730VHA	5.70	5	68	
1731	MP1731VHA	16.50	3	88	
1732	MP1732VHA	6.31	2	107	
1812	MP1812VHA	17.70	2	107	
1813	MP1813VHA	33.10	0	0	
1814	MP1814VHA	6.32	0	0	
1815	MP1815VHA	6.49	0	0	

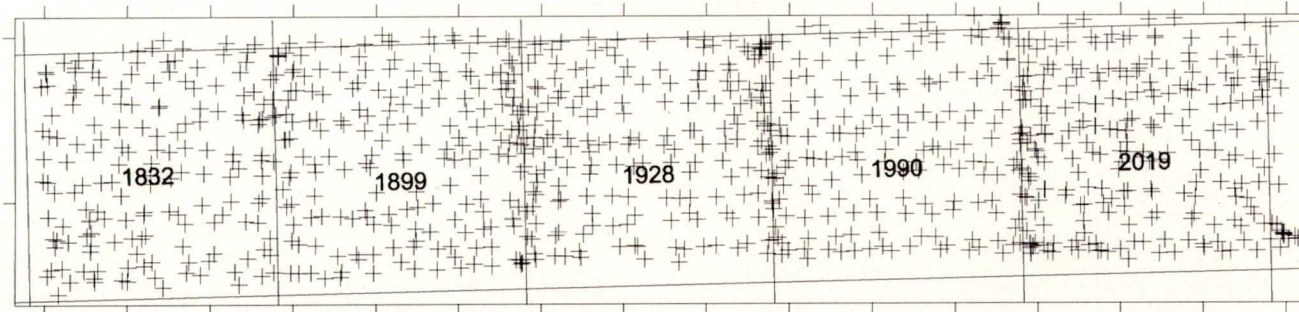
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



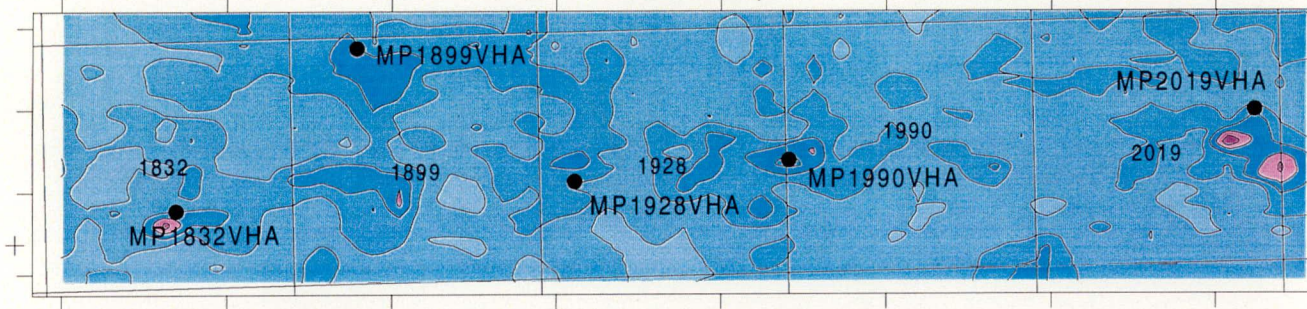
# MP181 Phase II LAV1832

GPS Track Map



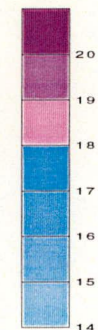
Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

uR/h



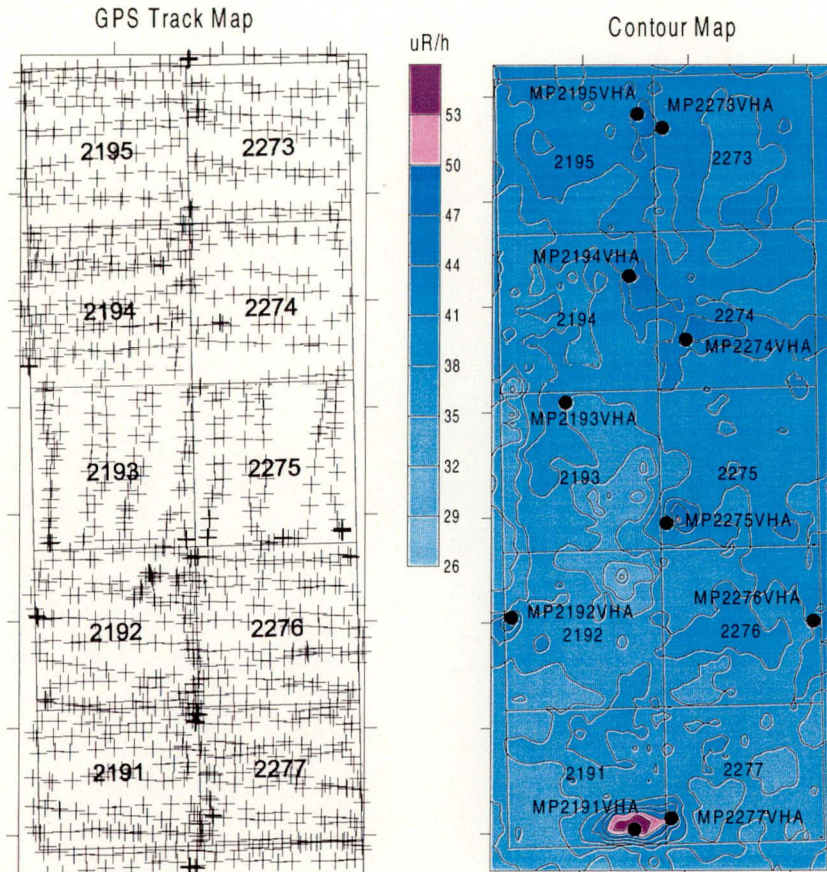
Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
1832	MP1832VHA	16.40	1	151	26.89
1899	MP1899VHA	6.27	1	151	
1928	MP1928VHA	3.08	1	151	
1990	MP1990VHA	13.80	1	151	
2019	MP2019VHA	94.90	2	107	

<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils

# MP181 Phase II LAV2191



Results of Sample Analysis

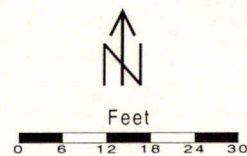
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
2191	MP2191VHA	51.70	7	58	10.999
2192	MP2192VHA	24.30	7	58	
2193	MP2193VHA	2.20	0	0	
2194	MP2194VHA	1.97	1	151	
2195	MP2195VHA	1.86	0	0	
2273	MP2273VHA	6.89	0	0	
2274	MP2274VHA	13.60	0	0	
2275	MP2275VHA	3.02	1	151	
2276	MP2276VHA	2.44	0	0	
2277	MP2277VHA	2.01	0	0	

<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils

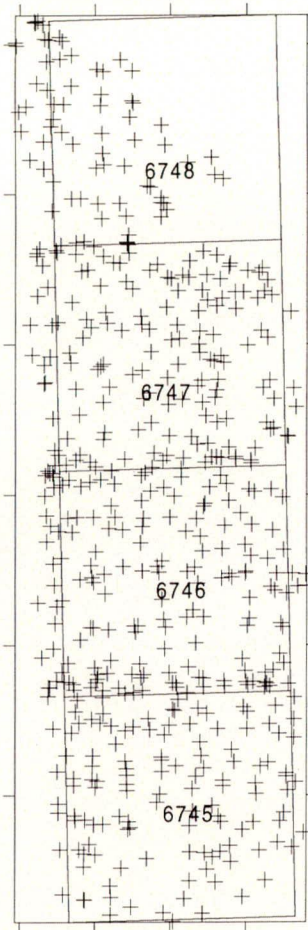
+ Gamma data point location collected using GPS.

● Soil Sample Location



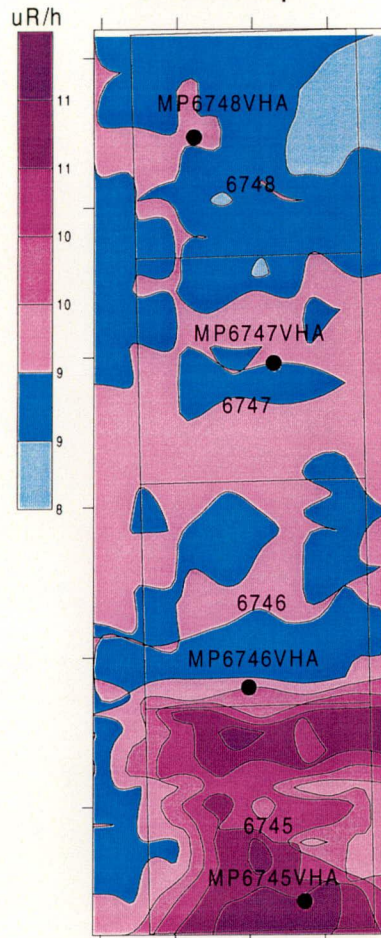
# MP00179 Phase III LAV6745

GPS Track Map



Gamma data point location  
collected using GPS.

Contour Map



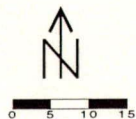
● Soil Sample Location

Results of Sample Analysis

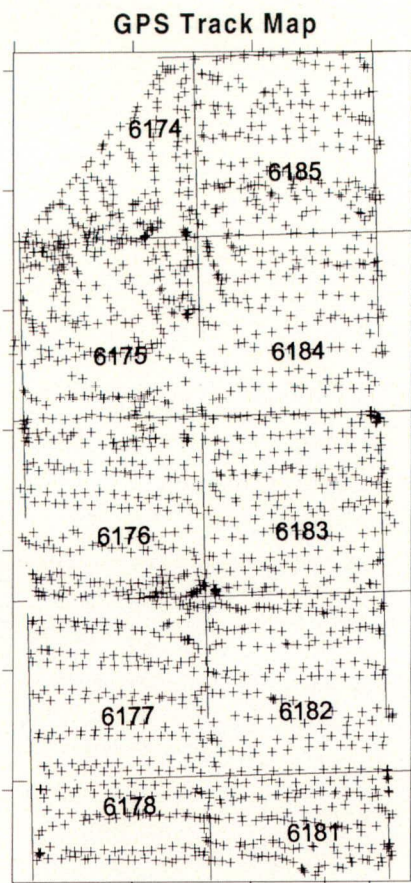
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
6745	MP6745VHA	3.48	0	0	3.565
6746	MP6746VHA	1.07	0	0	
6747	MP6747VHA	6.59	0	0	
6748	MP6748VHA	3.12	0	0	

■ <sup>226</sup>Ra concentration > 15 pCi/g

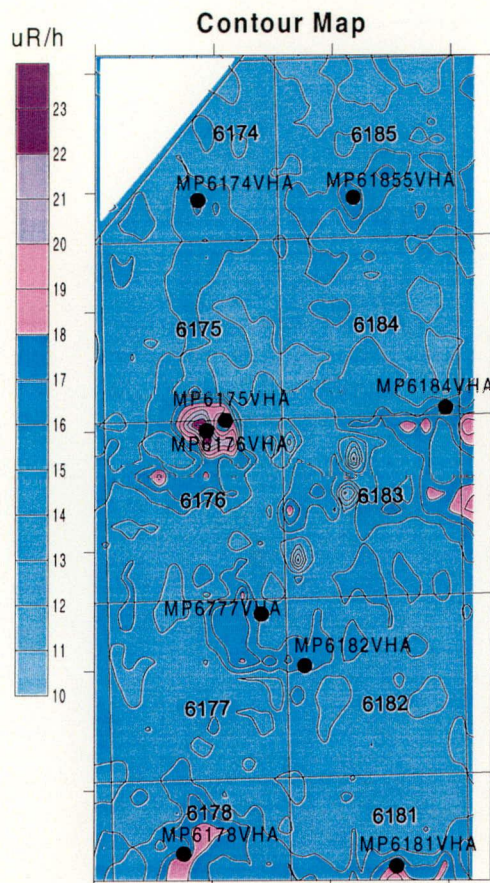
- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



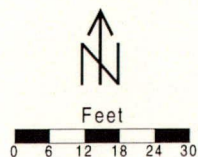
# MP179 Phase III LAV 6174



+ Gamma data point location collected using GPS.



● Soil Sample Location

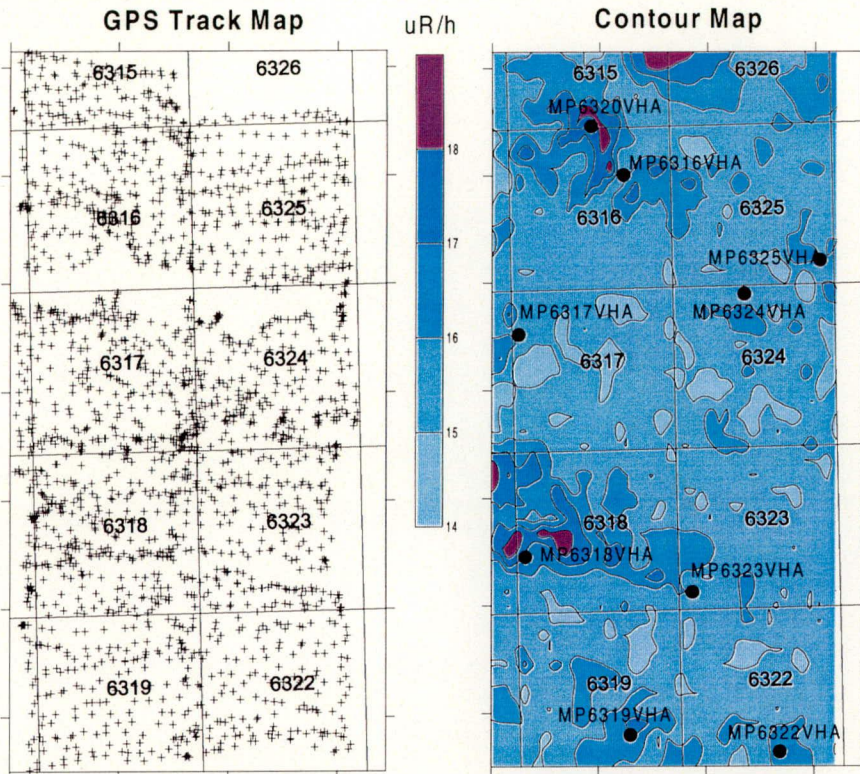


**Results of Sample Analysis**

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
6174	MP6174VHA	7.48	0	0	13.312
6175	MP6175VHA	41.40	0	0	
6176	MP6176VHA	9.34	10	48	
6177	MP6177VHA	4.61	3	88	
6178	MP6178VHA	6.23	2	107	
6181	MP6181VHA	23.50	2	107	
6182	MP6182VHA	7.59	0	0	
6183	MP6183VHA	11.90	0	0	
6184	MP6184VHA	14.00	2	107	
6185	MP6185VHA	7.07	0	0	

- <sup>226</sup>Ra concentration > 15 pCi/g
- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
  - \*\* Original values are concentrations reported before resampling
  - \*\*\* Hot spot limit for subsurface soils

# MP179 Phase III LAV 6316



+ Gamma data point location collected using GPS.

• Soil Sample Location

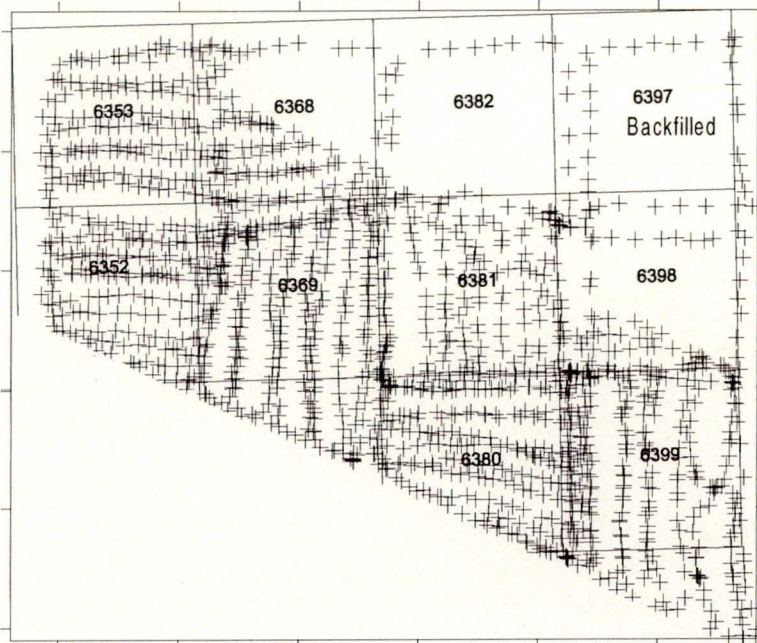
Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
6316	MP6316VHA	4.73	2	107	6.891
6317	MP6317VHA	5.56	1	151	
6318	MP6318VHA	14.60	2	107	
6319	MP6319VHA	6.01	0	0	
6320	MP6320VHA	4.81	1	151	
6322	MP6322VHA	3.24	0	0	
6323	MP6323VHA	4.64	0	0	
6324	MP6324VHA	5.63	1	151	
6325	MP6325VHA	12.80	1	151	

- <sup>226</sup>Ra concentration > 15 pCi/g
- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils

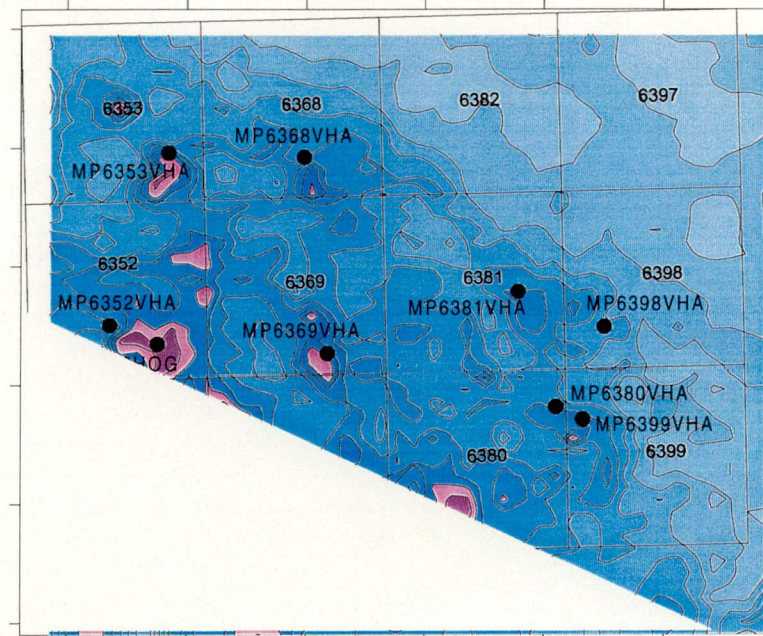
# MP179 Phase III LAV6352

GPS Track Map

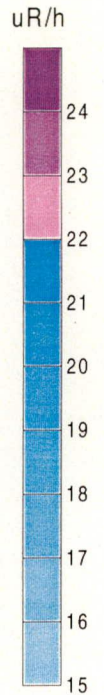


+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location



## Results of Sample Analysis

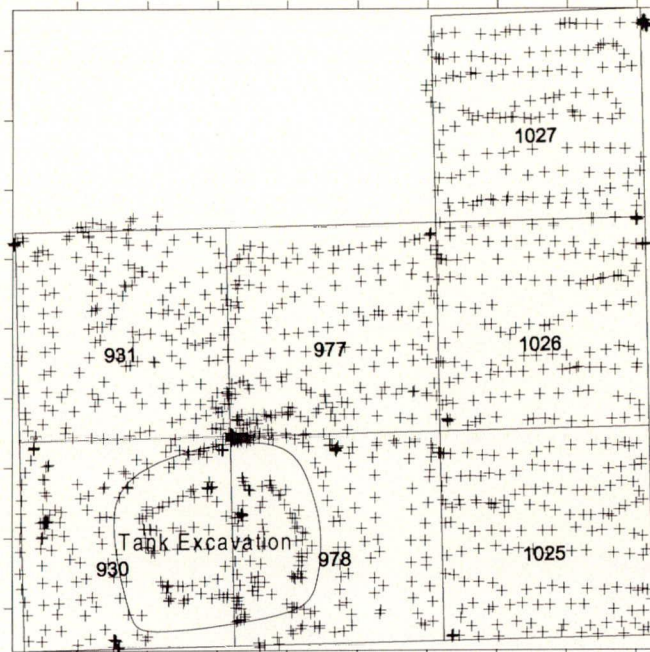
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
6352	MP6352VHA	4.84	10	48	13.914
6353	MP6353VHA	33.40	0	0	
6368	MP6368VHA	13.30	0	0	
6369	MP6369VHA	9.03	0	0	
6380	MP6380VHA	15.90	0	0	
6381	MP6381VHA	6.42	0	0	
6398	MP6398VHA	2.42	0	0	
6399	MP6399VHA	26.00	0	0	

<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils

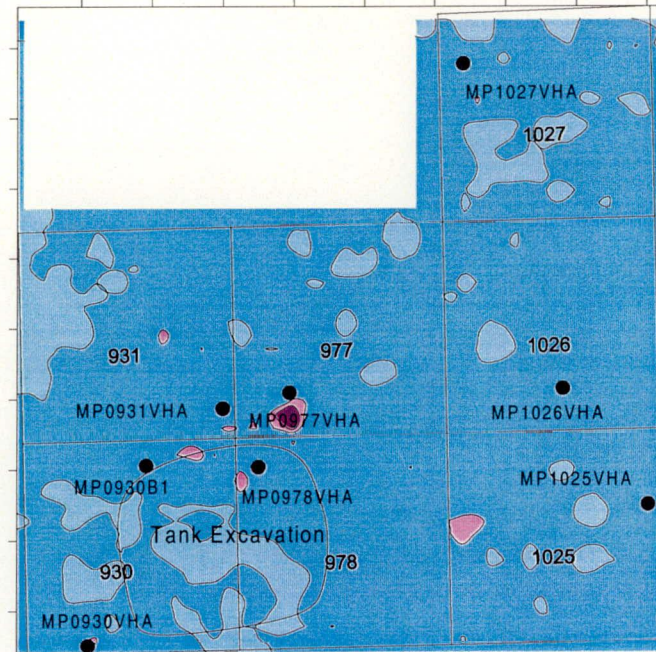
# MP181 Phase I MP930

GPS Track Map



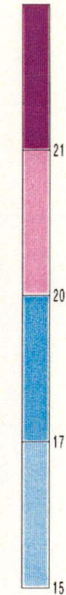
+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

uR/h



Results of Sample Analysis

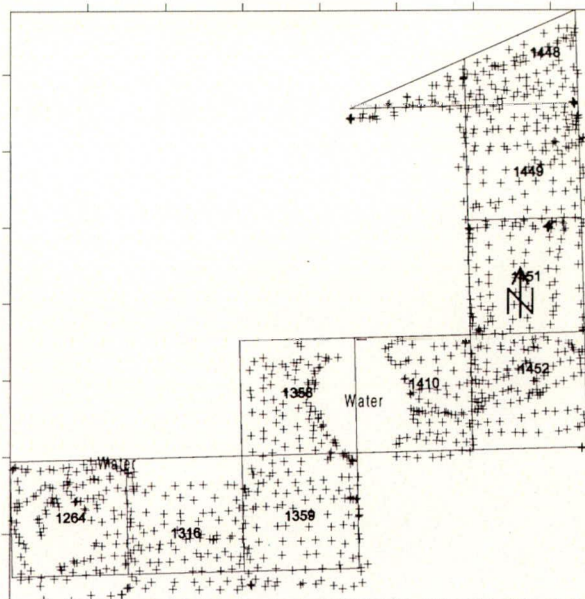
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
930	MP0930VHA	7.28	0	0	8.840
931	MP0931VHA	11.70	0	0	
977	MP0977VHA	18.30	0	0	
978	MP0978VHA	14.70	0	0	
1025	MP1025VHA	2.59	0	0	
1026	MP1026VHA	4.52	0	0	
1027	MP1027VHA	2.79	0	0	

<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils

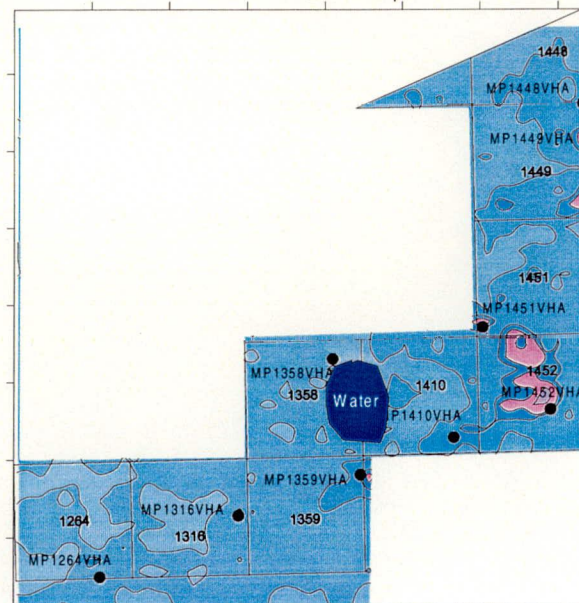
# MP181 Phase Ia LAV1264

GPS Track Map



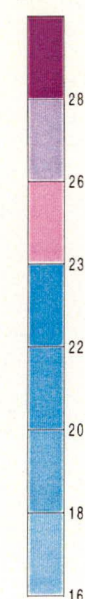
+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

uR/h

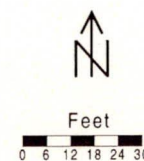


## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit***	Mean Avg*
				<sup>226</sup> Ra, pCi/g	<sup>226</sup> Ra, pCi/g
1264	MP1264VHA	2.57	0	0	11.618
1316	MP1316VHA	2.45	0	0	
1358	MP1358VHA	20.00	0	0	
1359	MP1359VHA	8.92	0	0	
1410	MP1410VHA	11.40	0	0	
1448	MP1448VHA	8.92	0	0	
1449	MP1449VHA	20.20	3	88	
1451	MP1451VHA	10.70	0	0	
1452	MP1452VHA	19.40	7	58	

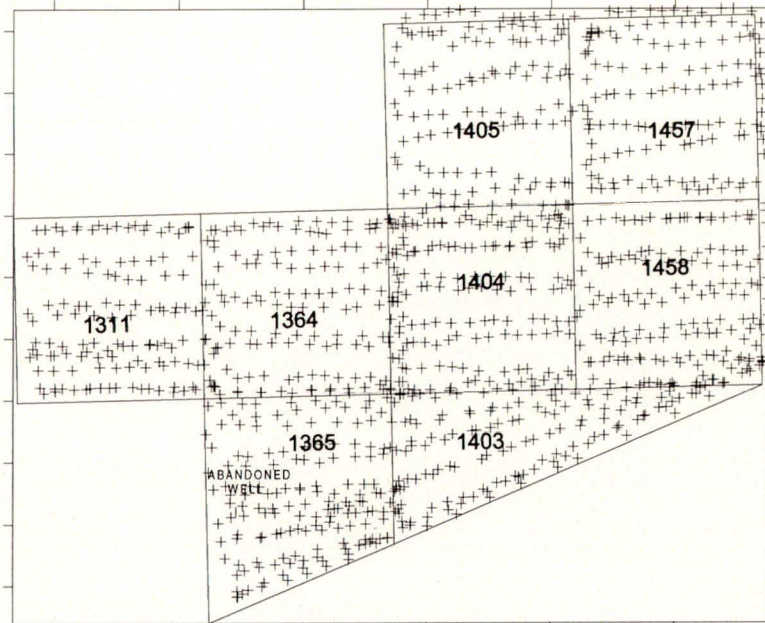
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



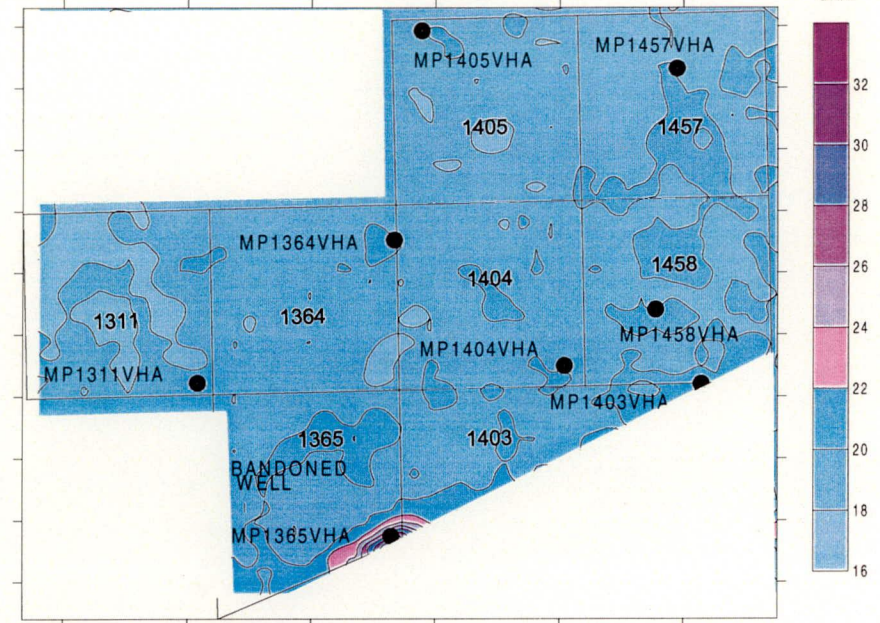
# MP181 Phase Ia/1b LAV1311

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
1311	MP1311VHA	1.41	0	0	6.8525
1364	MP1364VHA	1.87	0	0	
1365	MP1365VHA	44.90	5	68	
1403	MP1403VHA	1.10	1	151	
1404	MP1404VHA	1.58	0	0	
1405	MP1405VHA	1.15	0	0	
1457	MP1457VHA	1.50	0	0	
1458	MP1458VHA	1.31	0	0	

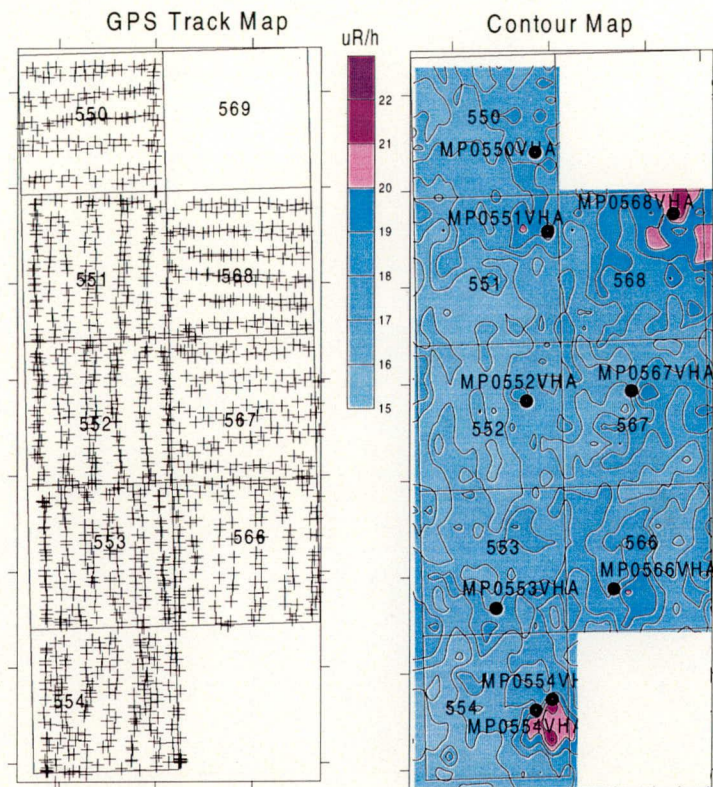
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



Feet  
0 6 12 18 24 30

# MP181 Phase II LAV550



Results of Sample Analysis

Block No.	Sample No.	$^{226}\text{Ra}$ , pCi/g	Area, m <sup>2</sup>	Limit*** $^{226}\text{Ra}$ , pCi/g	Mean Avg* $^{226}\text{Ra}$ , pCi/g
550	MP0550VHA	5.31	0	0	3.609
551	MP0551VHA	1.81	6	62	
552	MP0552VHA	2.81	0	0	
553	MP0553VHA	2.15	0	0	
554	MP0554VHA	3.74	0	0	
566	MP0566VHA	4.68	1	151	
567	MP0567VHA	2.14	1	151	
568	MP0568VHA	6.23	2	107	

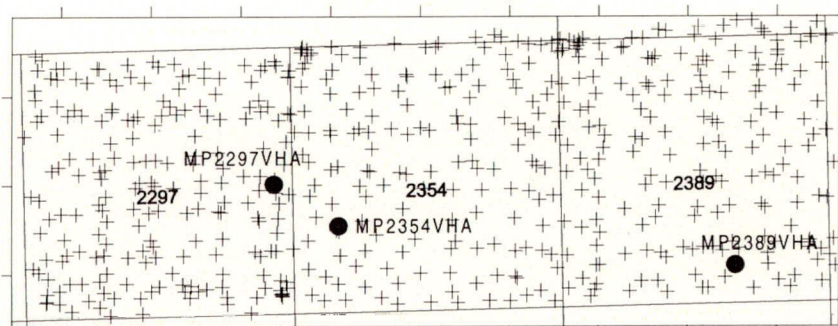
$^{226}\text{Ra}$  concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



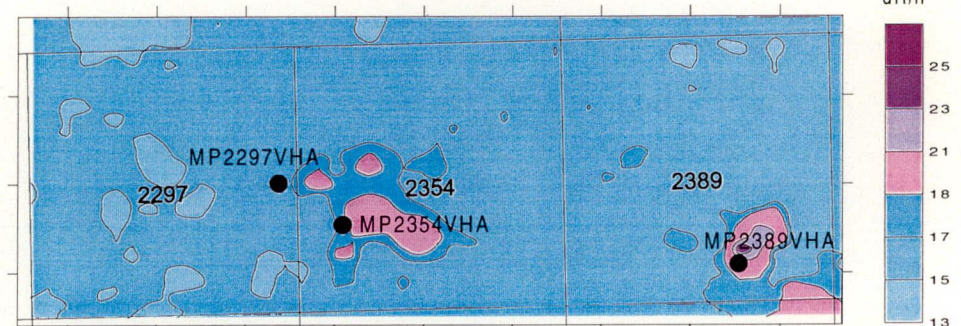
# MP181 Phase II LAV2297

GPS Track Map

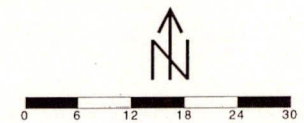


+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location



Results of Sample Analysis

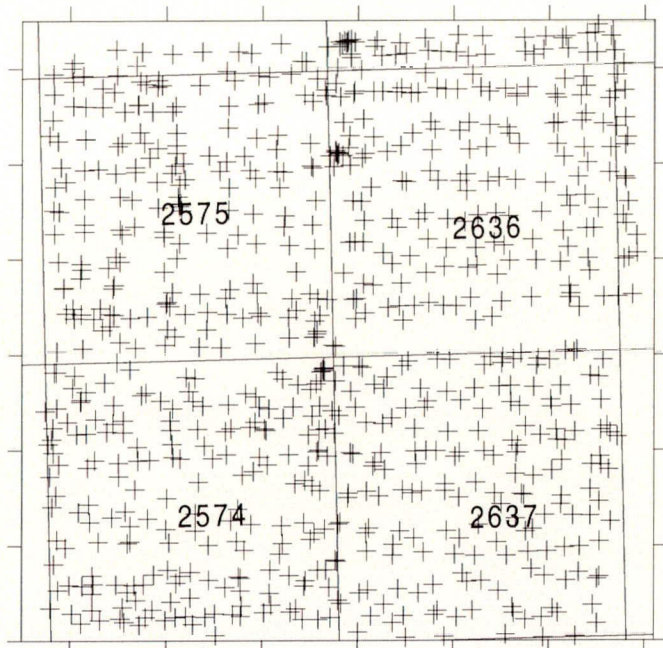
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
2297	MP2297VHA	6.39	0	0	45.163
2354	MP2354VHA	30.50	5	68	
2389	MP2389VHA	98.60	4	76	

<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils

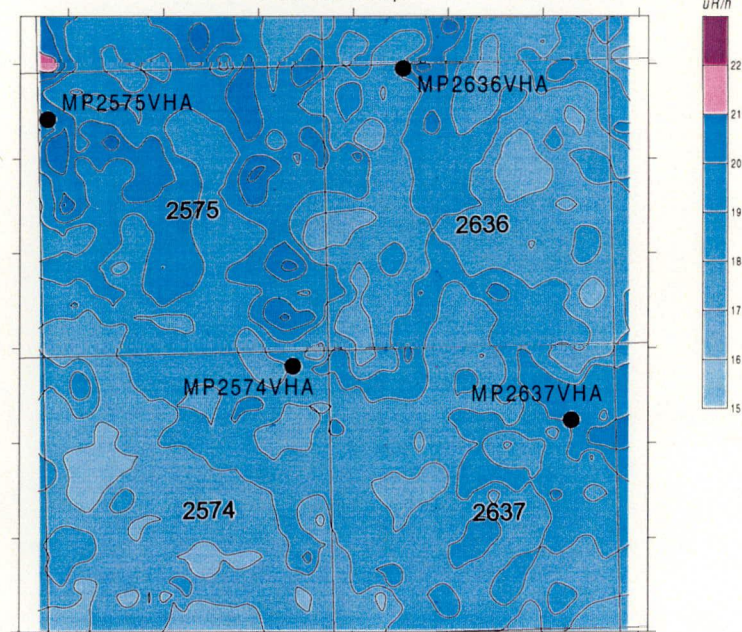
# MP181 Phase II LAV2574

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
2574	MP2574VHA	9.44	1	151	6.288
2575	MP2575VHA	3.24	1	151	
2636	MP2636VHA	3.93	0	0	
2637	MP2637VHA	8.54	1	151	

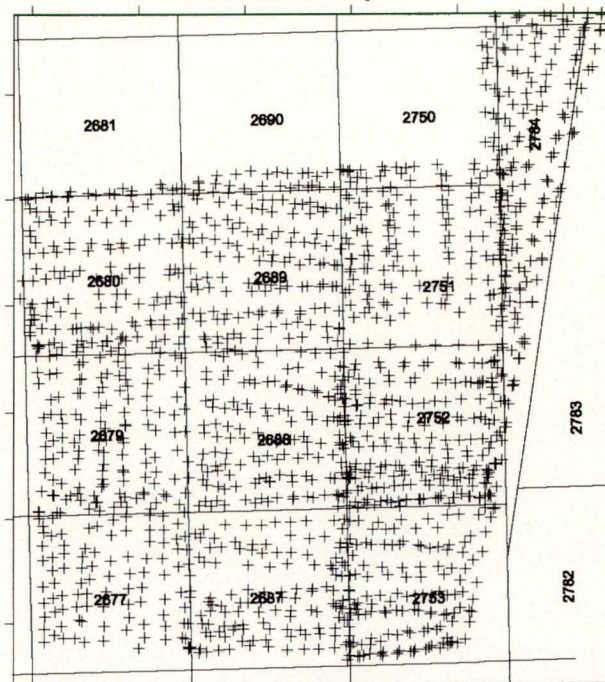
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



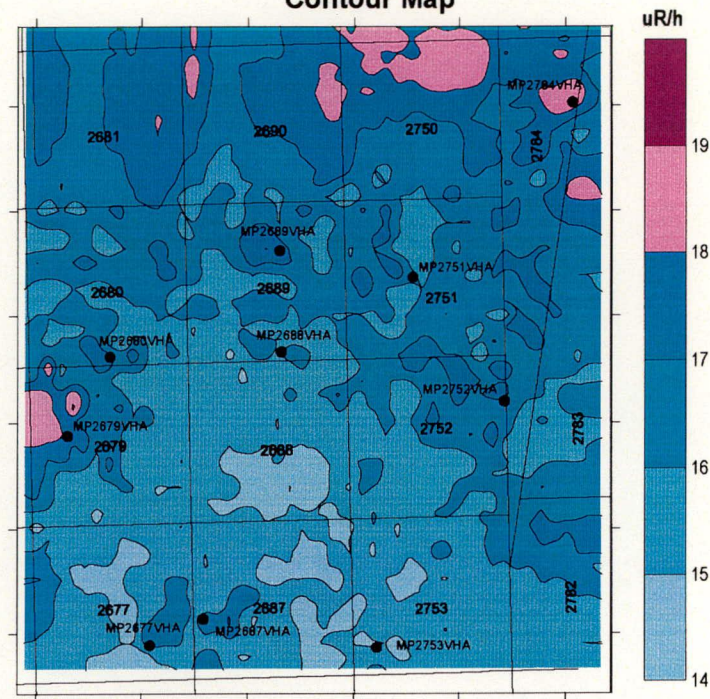
# MP181 Phase II LAV2677

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



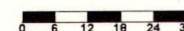
• Soil Sample Location

Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
2677	MP2677VHA	7.97	0	0	5.359
2679	MP2679VHA	15.30	5	62	
2680	MP2680VHA	1.25	0	0	
2687	MP2687VHA	22.50	1	151	
2688	MP2688VHA	1.04	0	0	
2689	MP2689VHA	1.59	1	151	
2751	MP2751VHA	0.92	1	151	
2752	MP2752VHA	0.97	1	151	
2753	MP2753VHA	1.02	0	0	
2784	MP2784VHA	1.03	0	0	

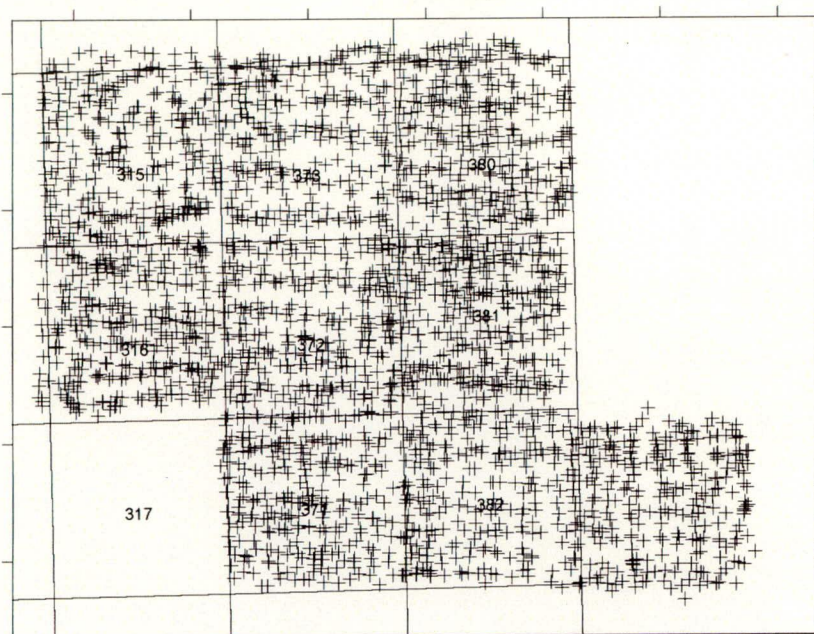
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



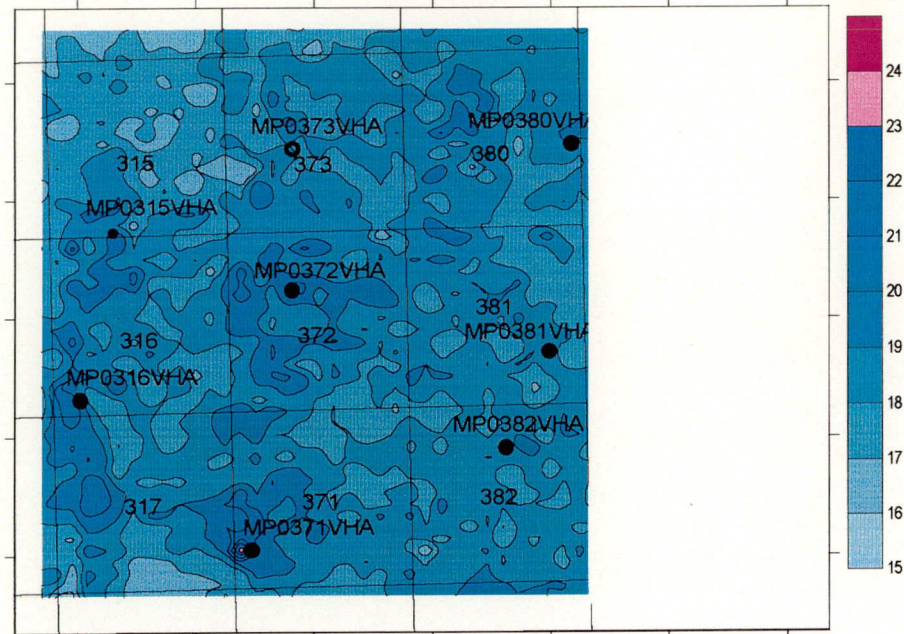
# MP181 Phase IV LAV315

Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
315	MP0315VHA	5.76	0	0	6.234
316	MP0316VHA	1.53	0	0	
371	MP0371VHA	16.50	0	0	
372	MP0372VHA	15.80	0	0	
373	MP0373VHA	2.99	0	0	
380	MP0380VHA	2.64	0	0	
381	MP0381VHA	3.09	0	0	
382	MP0382VHA	1.56	0	0	

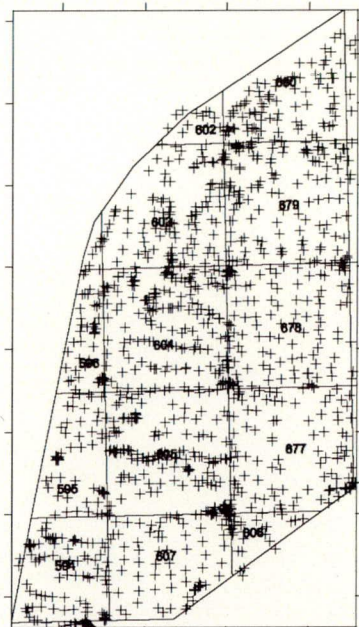
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



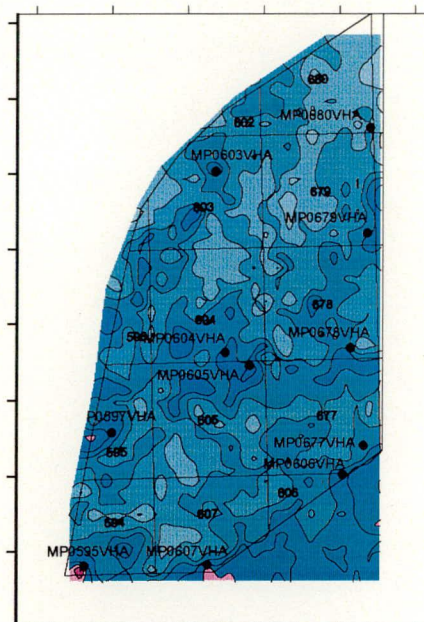
# MP00211 Phase II LAV604

GPS Track Map



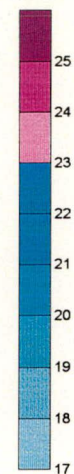
+ Gamma data point location collected using GPS.

Contour Map



• Soil Sample Location

ur/h



Results of Sample Analysis

Block No.	Sample No.	$^{226}\text{Ra}$ , pCi/g	Area, m <sup>2</sup>	Limit*** $^{226}\text{Ra}$ , pCi/g	Mean Avg* $^{226}\text{Ra}$ , pCi/g
595	MP0595VHA	7.69	1	151	2.875
597	MP0597VHA	4.04	0	0	
603	MP0603VHA	3.88	0	0	
604	MP0604VHA	2.42	0	0	
605	MP0605VHA	0.79	0	0	
606	MP0606VHA	1.02	0	0	
607	MP0607VHA	0.90	0	0	
677	MP0677VHA	2.54	0	0	
678	MP0678VHA	1.55	0	0	
679	MP0679VHA	2.66	0	0	
680	MP0680VHA	4.13	0	0	

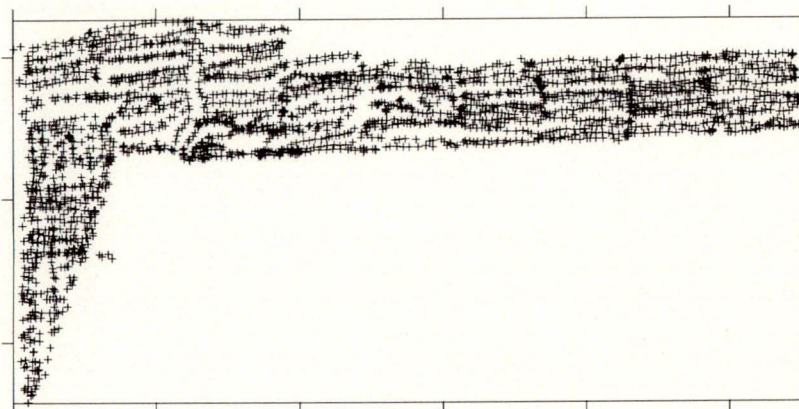
$^{226}\text{Ra}$  concentration > 15 pCi/g

\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.  
 \*\* Original values are concentrations reported before resampling  
 \*\*\* Hot spot limit for subsurface soils



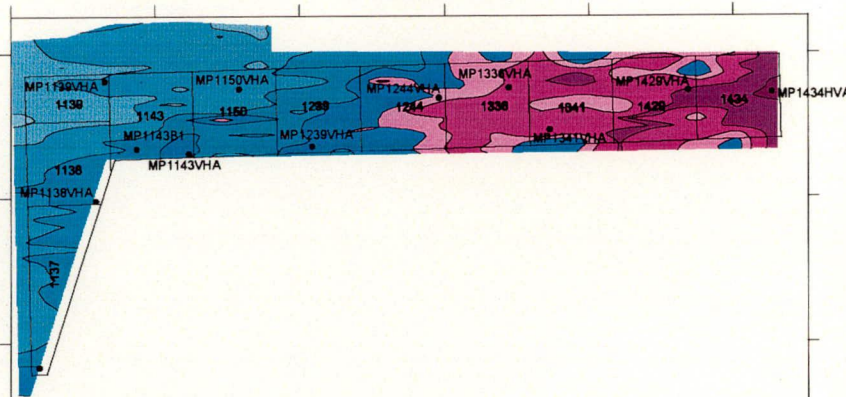
# MP00211 Phase II LAV1137

GPS Track Map



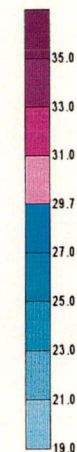
+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

uR/h



## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit***	Mean Avg*
				<sup>226</sup> Ra, pCi/g	<sup>226</sup> Ra, pCi/g
1137	MP1137VHA	4.45	0	0	4.177
1138	MP1138VHA	2.74	0	0	
1139	MP1139VHA	1.21	0	0	
1143	MP1143VHA	3.91	1	151	
1150	MP1150VHA	2.56	0	0	
1239	MP1239VHA	5.20	0	0	
1244	MP1244VHA	2.73	0	0	
1336	MP1336VHA	6.95	0	0	
1341	MP1341VHA	3.01	0	0	
1429	MP1429VHA	1.99	0	0	
1434	MP1434VHA	11.20	0	0	

  <sup>226</sup>Ra concentration > 15 pCi/g

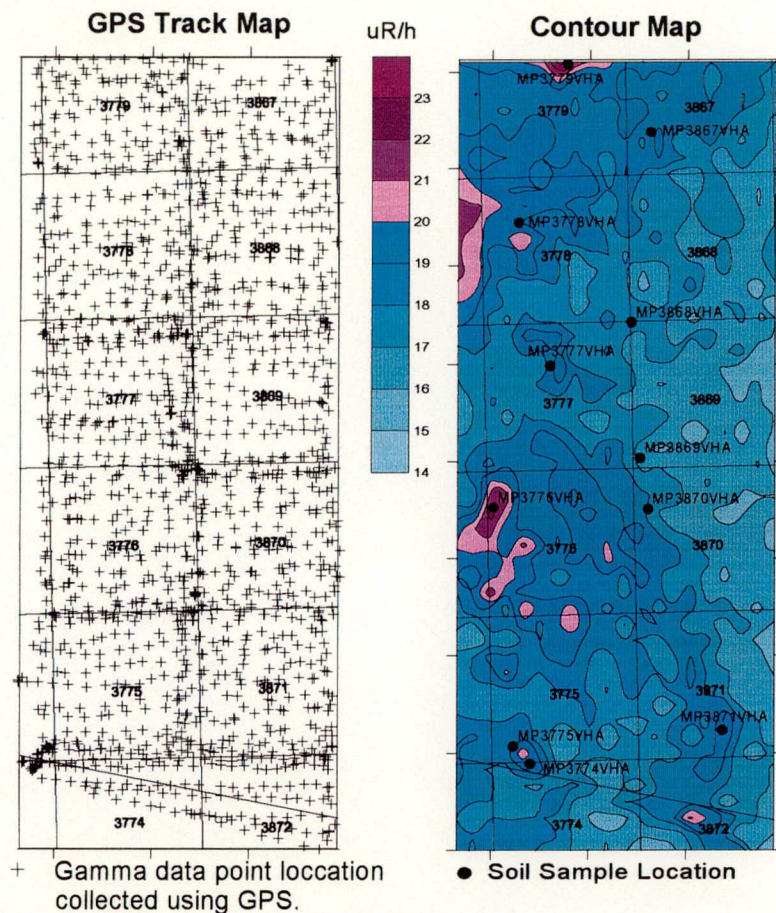
\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

\*\* Original values are concentrations reported before resampling

\*\*\* Hot spot limit for subsurface soils



# MP00391 PHASE IV LAV 3774



Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
3774	MP3774VHA	3.00	1	151	4.931
3775	MP3775VHA	2.97	0	0	
3776	MP3776VHA	16.80	5	68	
3777	MP3777VHA	2.07	1	151	
3778	MP3778VHA	8.20	1	151	
3779	MP3779VHA	4.60	1	151	
3867	MP3867VHA	1.74	1	151	
3868	MP3868VHA	1.46	0	0	
3869	MP3869VHA	3.26	5	68	
3870	MP3870VHA	4.95	19	35	
3871	MP3871VHA	5.19	1	151	

<sup>226</sup>Ra concentration > 15 pCi/g

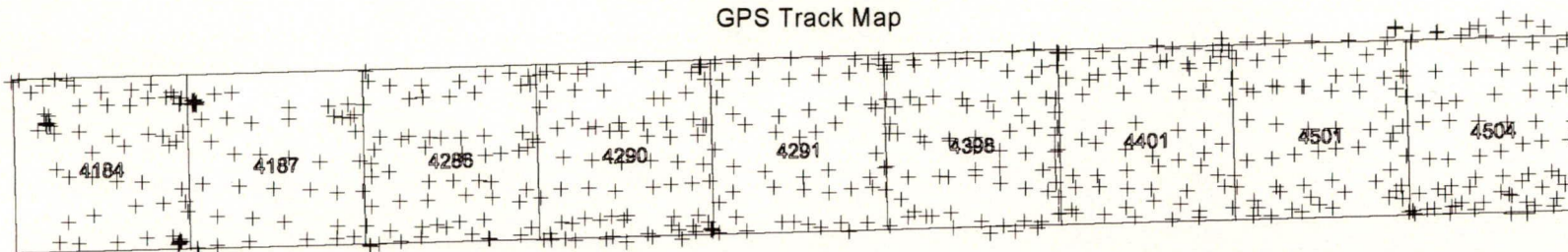
\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

\*\* Original values are concentrations reported before resampling

\*\*\* Hot spot limit for subsurface soils

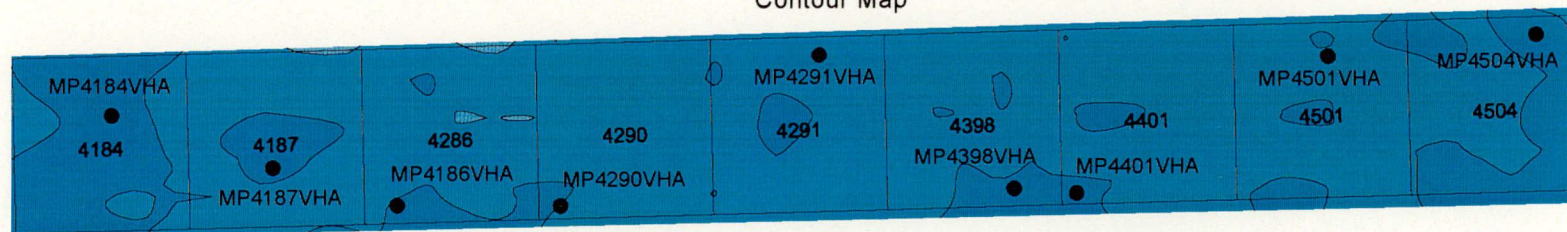
# MP00391 PHASE IV LAV 4184

GPS Track Map



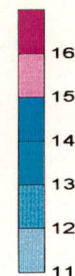
+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

uR/h



Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
4184	MP4184VHA	8.05	0	0	3.49
4187	MP4187VHA	10.40	0	0	
4286	MP4286VHA	1.50	0	0	
4290	MP4290VHA	1.60	0	0	
4291	MP4291VHA	1.66	0	0	
4398	MP4398VHA	1.82	0	0	
4401	MP4401VHA	1.85	0	0	
4501	MP4501VHA	1.26	0	0	
4504	MP4504VHA	3.27	0	0	

<sup>226</sup>Ra concentration > 15 pCi/g

\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

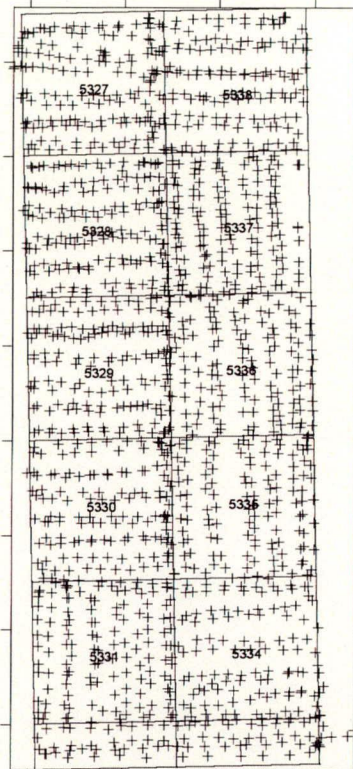
\*\* Original values are concentrations reported before resampling

\*\*\* Hot spot limit for subsurface soils

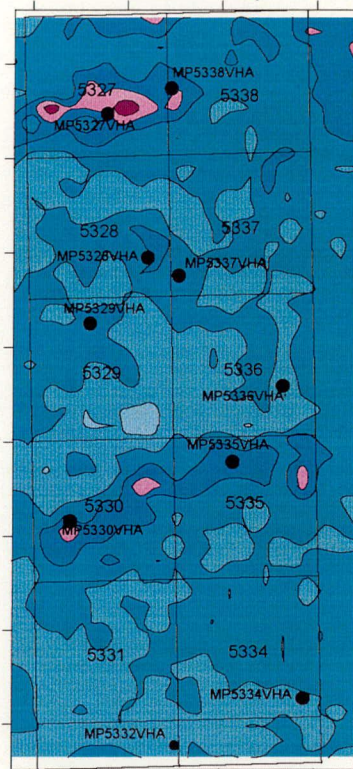


# 391 PHASE IV LAV 5327

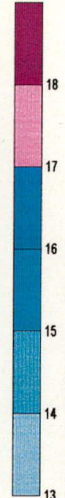
GPS Track Map



Contour Map



uR/h



Results of Sample Analysis

Block No.	Sample No.	$^{226}\text{Ra}$ , pCi/g	Area, m <sup>2</sup>	Limit*** $^{226}\text{Ra}$ , pCi/g	Mean Avg* $^{226}\text{Ra}$ , pCi/g
5327	MP5327VHA	3.34	12	44	3.108
5328	MP5328VHA	3.13	1	151	
5329	MP5329VHA	7.14	1	151	
5330	MP5330VHA	6.30	5	68	
5331	MP5331VHA	0.99	1	151	
5332	MP5332VHA	0.97	0	0	
5334	MP5334VHA	1.06	0	0	
5335	MP5335VHA	5.63	1	151	
5336	MP5336VHA	1.02	0	0	
5337	MP5337VHA	1.49	1	151	
5338	MP5338VHA	3.11	1	151	

\*  $^{226}\text{Ra}$  concentration > 15 pCi/g

\*\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

\*\*\* Original values are concentrations reported before resampling

Hot spot limit for subsurface soils

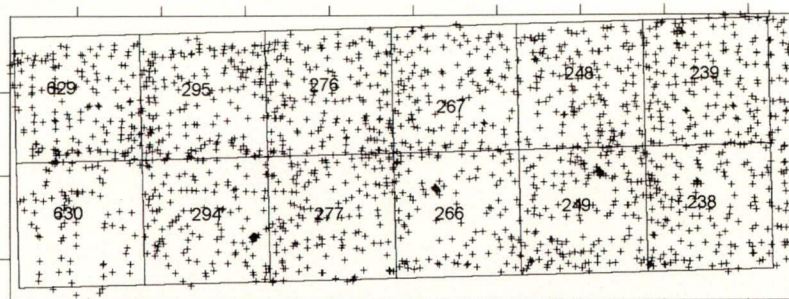
+ Gamma data point location  
collected using GPS.

• Soil Sample Location



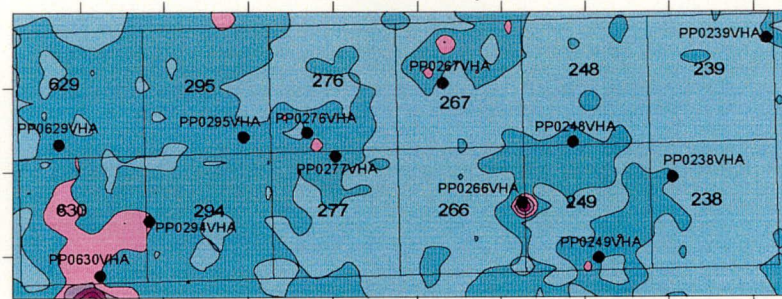
# MP00845 LAV 24

GPS Track Map

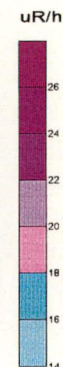


+ Gamma data point location collected using GPS.

Contour Map



• Soil Sample Location



Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
238	PP0238VHA	10.90	0	0	5.988
239	PP0239VHA	5.19	0	0	
248	PP0248VHA	10.90	0	0	
249	PP0249VHA	1.50	0	0	
266	PP0266VHA	1.80	0	0	
267	PP0267VHA	13.00	0	0	
276	PP0276VHA	1.70	0	0	
277	PP0277VHA	1.91	0	0	
294	PP0294VHA	12.50	0	0	
295	PP0295VHA	9.35	0	0	
629	PP0629VHA	1.60	0	0	
630	PP0630VHA	1.50	0	0	

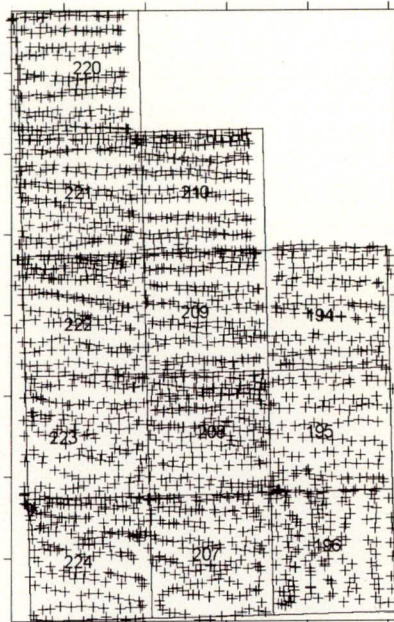
<sup>226</sup>Ra concentration > 15 pCi/g

- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



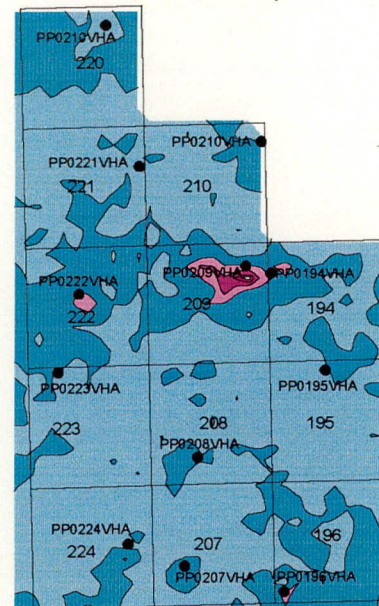
# MP00845 LAV32

GPS Track Map

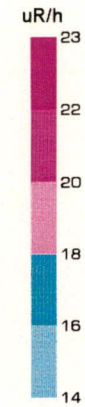


+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location



Results of Sample Analysis

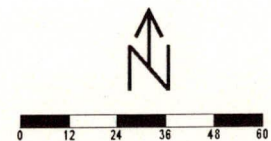
Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
194	PP0194VHA	1.60	0	0	3.088
195	PP0195VHA	1.70	0	0	
196	PP0196VHA	1.60	0	0	
207	PP0207VHA	5.64	0	0	
208	PP0208VHA	1.94	0	0	
209	PP0209VHA	2.80	0	0	
210	PP0210VHA	4.84	0	0	
220	PP0220VHA	4.89	0	0	
221	PP0221VHA	7.01	0	0	
222	PP0222VHA	1.40	0	0	
223	PP0223VHA	1.83	0	0	
224	PP0224VHA	1.80	0	0	

<sup>226</sup>Ra concentration > 15 pCi/g

\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

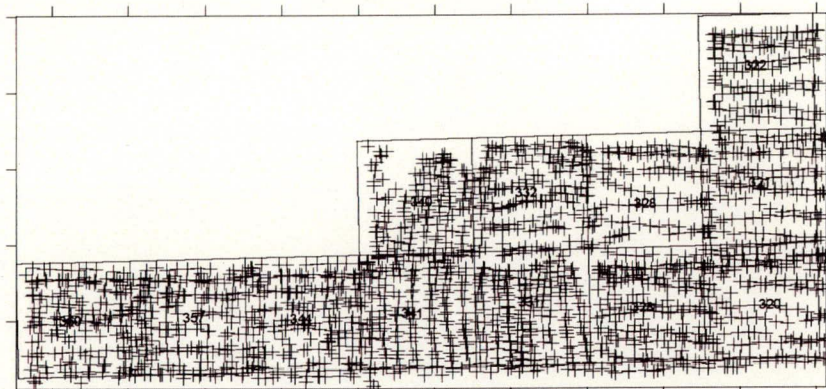
\*\* Original values are concentrations reported before resampling

\*\*\* Hot spot limit for subsurface soils



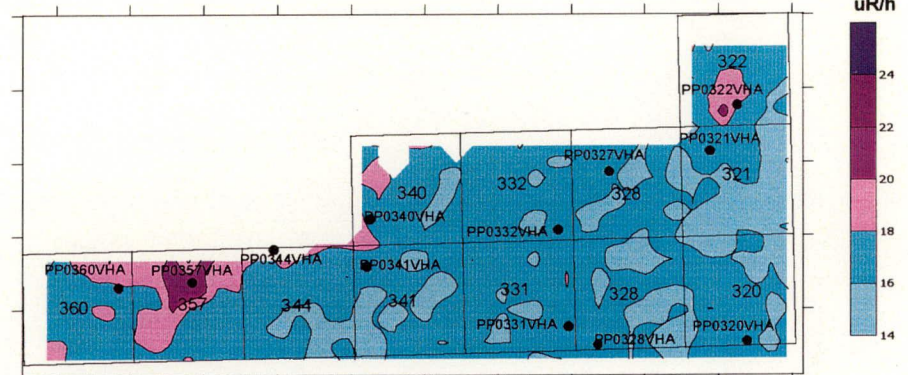
# MP00845 LAV35

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



• Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit*** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
320	PP0320VHA	1.90	0	0	10.36
321	PP0321VHA	2.37	0	0	
322	PP0322VHA	9.39	0	0	
327	PP0327VHA	2.34	0	0	
328	PP0328VHA	6.55	0	0	
331	PP0331VHA	3.42	0	0	
332	PP0332VHA	5.08	0	0	
340	PP0340VHA	14.00	0	0	
341	PP0341VHA	7.47	0	0	
344	PP0344VHA	16.00	0	0	
357	PP0357VHA	15.00	0	0	
360	PP0360VHA	40.80	0	0	

<sup>226</sup>Ra concentration > 15 pCi/g

\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

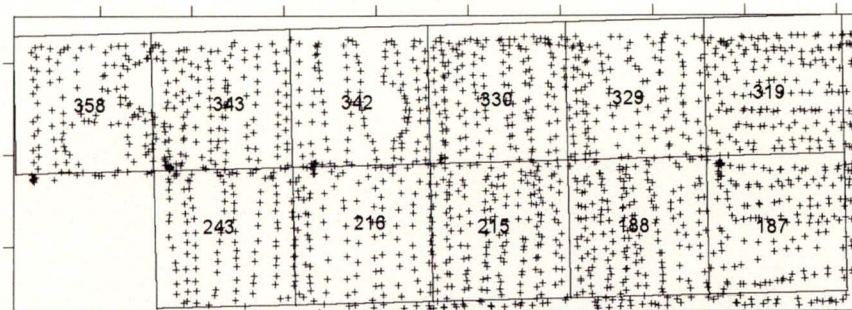
\*\* Original values are concentrations reported before resampling

\*\*\* Hot spot limit for subsurface soils



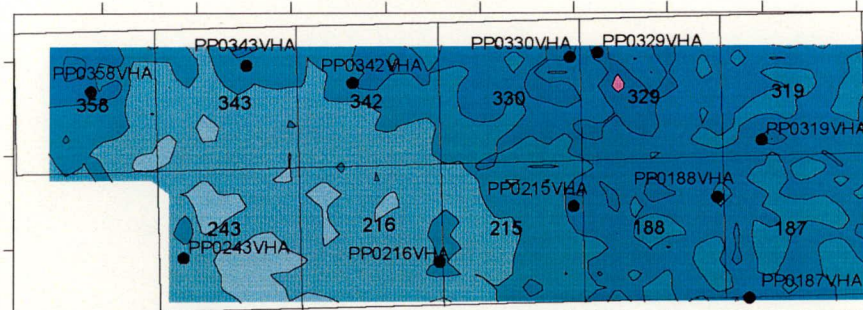
# MP00845 LAV36

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	<sup>226</sup> Ra, pCi/g	Area, m <sup>2</sup>	Limit**** <sup>226</sup> Ra, pCi/g	Mean Avg* <sup>226</sup> Ra, pCi/g
187	PP0187VHA	2.04	0	0	3.497
188	PP0188VHA	1.60	0	0	
215	PP0215VHA	1.79	0	0	
216	PP0216VHA	1.16	0	0	
243	PP0243VHA	0.89	0	0	
319	PP0319VHA	2.55	0	0	
329	PP0329VHA	7.55	0	0	
330	PP0330VHA	2.57	0	0	
342	PP0342VHA	3.41	0	0	
343	PP0343VHA	3.81	0	0	
358	PP0358VHA	11.10	0	0	

<sup>226</sup>Ra concentration > 15 pCi/g

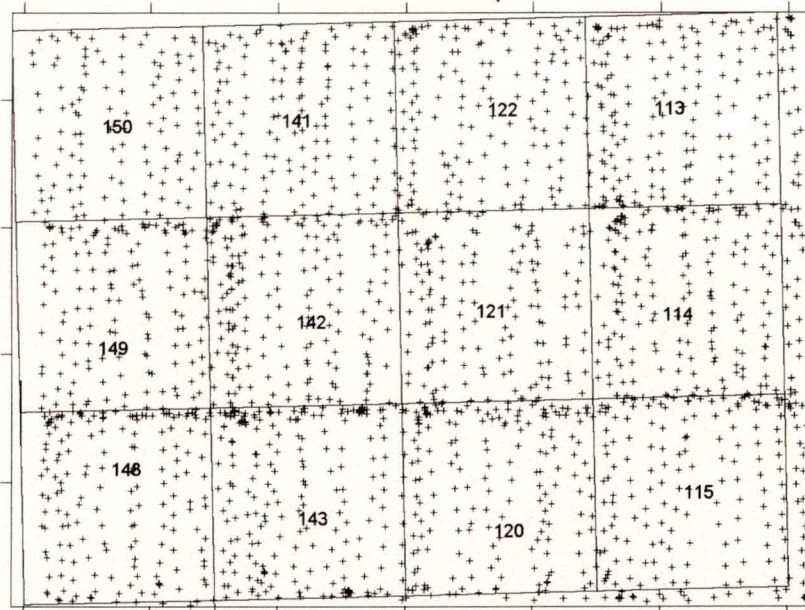
- \* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.
- \*\* Original values are concentrations reported before resampling
- \*\*\* Hot spot limit for subsurface soils



## **Appendix C. Statistics**

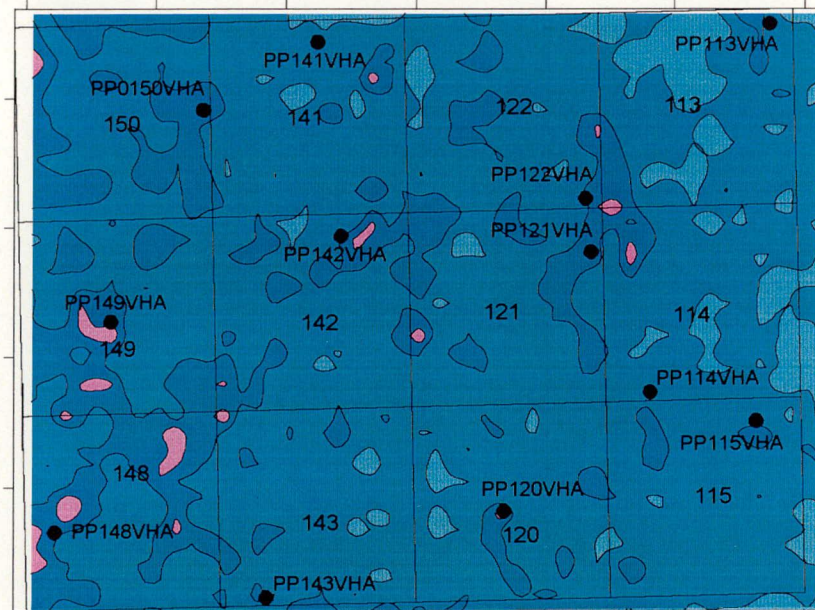
# MP00845 LAV56

GPS Track Map



+ Gamma data point location collected using GPS.

Contour Map



● Soil Sample Location

## Results of Sample Analysis

Block No.	Sample No.	$^{226}\text{Ra}$ , pCi/g	Area, m <sup>2</sup>	Limit*** $^{226}\text{Ra}$ , pCi/g	Mean Avg* $^{226}\text{Ra}$ , pCi/g
113	PP0113VHA	1.94	0	0	2.123
114	PP0114VHA	1.68	0	0	
115	PP0115VHA	1.89	0	0	
120	PP0120VHA	2.12	0	0	
121	PP0121VHA	1.91	0	0	
122	PP0122VHA	2.73	0	0	
141	PP0141VHA	1.67	0	0	
142	PP0142VHA	2.53	0	0	
143	PP0143VHA	2.13	0	0	
148	PP0148VHA	2.77	0	0	
149	PP0149VHA	2.18	0	0	
150	PP0150VHA	1.93	0	0	

$^{226}\text{Ra}$  concentration > 15 pCi/g

\* Mathematical average of the concentrations of the aliquots. Comparable to a composite concentration.

\*\* Original values are concentrations reported before resampling

\*\*\* Hot spot limit for subsurface soils



**Table C.1. Sorted Ra-226 data (pCi/g)**

0.794	1.66	2.56	4.11	7.07	12.5	51.7
0.888	1.67	2.57	4.13	7.14	12.8	94.9
0.901	1.68	2.57	4.25	7.28	13	98.6
0.92	1.7	2.59	4.45	7.3	13.3	
0.97	1.7	2.61	4.45	7.47	13.3	
0.974	1.74	2.63	4.52	7.47	13.3	
0.991	1.79	2.64	4.6	7.48	13.6	
1.02	1.79	2.66	4.61	7.48	13.8	
1.02	1.79	2.69	4.64	7.55	13.8	
1.02	1.8	2.73	4.68	7.59	13.9	
1.03	1.8	2.73	4.73	7.6	14	
1.03	1.81	2.74	4.81	7.69	14	
1.04	1.82	2.77	4.84	7.71	14.6	
1.06	1.83	2.79	4.84	7.97	14.7	
1.07	1.85	2.8	4.89	8.05	14.8	
1.07	1.85	2.81	4.95	8.1	15	
1.07	1.86	2.97	5.08	8.18	15	
1.1	1.87	2.99	5.19	8.2	15.3	
1.15	1.89	3	5.19	8.29	15.7	
1.16	1.9	3.01	5.2	8.29	15.8	
1.21	1.91	3.02	5.25	8.35	15.9	
1.23	1.91	3.04	5.31	8.54	15.9	
1.25	1.93	3.08	5.43	8.92	16	
1.26	1.94	3.09	5.44	8.92	16.1	
1.31	1.94	3.11	5.56	9	16.4	
1.35	1.97	3.12	5.63	9.03	16.5	
1.35	1.99	3.13	5.63	9.04	16.5	
1.38	2.01	3.13	5.64	9.19	16.8	
1.4	2.04	3.2	5.7	9.34	17	
1.41	2.06	3.22	5.76	9.35	17.7	
1.43	2.07	3.24	6.01	9.39	18.3	
1.46	2.12	3.24	6.05	9.44	18.6	
1.49	2.13	3.26	6.23	10	18.7	
1.5	2.14	3.27	6.23	10.3	18.7	
1.5	2.15	3.34	6.27	10.4	19.4	
1.5	2.18	3.41	6.27	10.7	20	
1.5	2.2	3.42	6.3	10.8	20.2	
1.53	2.27	3.48	6.31	10.8	22.5	
1.55	2.3	3.51	6.32	10.9	23.5	
1.56	2.34	3.73	6.39	10.9	24.3	
1.58	2.37	3.74	6.42	11.1	26	
1.59	2.42	3.81	6.49	11.2	30.5	
1.6	2.42	3.86	6.49	11.2	33.1	
1.6	2.44	3.88	6.55	11.4	33.4	
1.6	2.45	3.91	6.59	11.7	40.6	
1.6	2.53	3.93	6.89	11.7	40.8	
1.6	2.54	3.99	6.95	11.9	41.4	
1.64	2.55	4.04	7.01	12.1	44.9	

<b>Table C.2. Descriptive Statistics for Ra-226 (pCi/g)</b>	
Mean	7.564735395
Standard Error	0.624754292
Median	4.13
Mode	1.6
Standard Deviation	10.65750986
Sample Variance	113.5825164
Kurtosis	34.66734961
Skewness	4.97419375
Range	97.806
Minimum	0.794
Maximum	98.6
Sum	2201.338
Count	291
Confidence Level(95.0%)	1.229627883

The table below gives percentiles and nonparametric one-sided upper confidence limits. Values are equivalent to nonparametric one-sided upper tolerance bounds.

<b>Table C-3. 95% Upper Confidence Limits</b>		
	<b>Percentile Estimate (pCi/g)</b>	<b>Upper Limit (pCi/g)</b>
50 <sup>th</sup>	4.13	4.95
75 <sup>th</sup>	9.04	10.86
80 <sup>th</sup>	11.10	13.30
85 <sup>th</sup>	13.70	15.16
86 <sup>th</sup>	13.94	15.81
87 <sup>th</sup>	14.63	15.97
88 <sup>th</sup>	15.00	16.43
89 <sup>th</sup>	15.71	16.76
90 <sup>th</sup>	15.90	17.95
91 <sup>st</sup>	16.37	18.69
92 <sup>nd</sup>	16.74	19.65
93 <sup>rd</sup>	18.12	22.18
94 <sup>th</sup>	18.70	24.75
95 <sup>th</sup>	20.10	32.10
96 <sup>th</sup>	23.82	39.87
97 <sup>th</sup>	31.28	41.70
98 <sup>th</sup>	40.64	57.24
99 <sup>th</sup>	45.58	98.20

Fig. C-1. Distribution plot showing nonparametric confidence limits.

